TROPICAL AGRICULTURE

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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

PLANT QUARANTINE STATIONS.

THE danger of introducing serious pests and diseases on or in living plants or plant products has been realised for many years in numerous countries. And in order to minimise this danger protective measures in the form of inspection at the port of entry is in force in most of the agricultural countries of the world. But in spite of the conscientious surveillance of the officers of the plant protection services a number of sharp lessons have shown that such precautions, although extremely helpful and essential, do not adequately protect a country from the introduction of pests and diseases. Numerous instances of such leakages are known which have caused serious dislocation of trade over extensive territories and the expenditure of large sums of money before the evil effects have been brought under control. In this respect the history of citrus canker (*Phytomonas citri*) in the United States of America and in South Africa is of interest. This destructive disease appears to have been introduced into Texas, Mississippi, Alabama and Florida on both seedling trees of Trifoliate Orange (*Poncirus trifoliata*) and on Satsuma orange trees shipped from Japan in 1911. It was not recognised as a serious menace in these states until 1914 and since its symptoms are somewhat similar to those of scab disease caused by the fungus *Sporotrichum citri*, its true cause was not known until 1915 by which time it had become widely spread. Similarly citrus canker was introduced into the Union of South Africa on shipments of citrus trees from Japan. The most recent reports show that the disease has now been eradicated both in the United States and in South Africa but this has only been possible after putting into effect the bold, expensive, but nevertheless effective, and economic policy of completely destroying citrus trees within affected areas. The cost in each case has run into millions of pounds sterling.

Different species and varieties of citrus differ markedly in their susceptibility to canker and this fact coupled with wide variation in climatic conditions in different countries makes the disease a most serious one in some citrus-growing countries and of comparatively little importance in others. The Tahiti lime, though not completely immune, is very resistant to canker disease so that it does not develop on this host except to a very mild extent. At the other extreme, grapefruit (*Citrus maxima* var. *uvacarpa*) is extremely susceptible and a medium position in this respect is taken by limes (*C. aurantifolia*) and sweet oranges (*C. sinensis*). It is evident, therefore, that though the Tahiti lime is itself highly

resistant it can still effectively function as a carrier of the disease to the more susceptible varieties of citrus. Moreover, it would be extremely difficult, if not impossible, for an inspecting officer at the port of entry to diagnose inconspicuous lesions of citrus canker on plants of Tahiti lime and some other citrus varieties. It has, therefore, become necessary to adopt fuller and more effective measures to minimise still further the ravages of such dangerous plant parasites.

For this purpose several countries demand that a certain form of health certificate, signed by a competent authority, should accompany each consignment of specified plants or plant products, which states that certain prescribed conditions have been fulfilled. At the instigation of Mr. Stockdale, the Colonial Agricultural Adviser, a standard certificate was framed at the Third Imperial Mycological Conference, held in London last September, with the proposal that it be adopted for use throughout the British Empire. This certificate, which is incorporated in the regulations of the Plant Quarantine Station at this College, meets all contingencies since it provides also for the use, in exceptional circumstances, of an additional certificate or certificates to cover imports specifically scheduled by the importing country. In the case of the above quarantine station this additional certificate has taken the form of a supplementary clause. In addition to demanding certificates to cover large and commercial consignments of living plants and plant products steps have been taken in some countries, notably the British Empire and the United States of America, to establish plant quarantine stations through which all or specified plant material, destined to be used for propagation purposes, must first pass. This is particularly applicable to commercial crop plants but the fact that certain weeds and ornamental plants may be alternative hosts to pests and diseases known to occur on certain crops is a matter of importance and is also taken into consideration. This aspect of the problem can be gathered from the regulations, of the Plant Quarantine Station recently established at this College. The thought might occur to those inexperienced in such matters that the cheapest and most effective method of avoiding the introduction of harmful crop parasites would be by means of legislation completely prohibiting the importation of new varieties. That such a measure if carried out would be the most effective of all is obvious but it is perhaps advisable to stress that such legislation would be unsound from several points of view. Prohibitive legislation stimulates into action the adventurous or rebellious natures of a number of people with the result that they, though otherwise law-abiding, would run grave risks to themselves and others in their endeavour to circumvent the law. The results of the law prohibiting the sale of alcoholic beverages in the United States of America is sufficient proof of this. On the other hand, the very reason for the introduction of new species and varieties of crop plants in a country is, in many cases, due to the fact that the existing crops in that country have proved uneconomic because of the serious damage caused by pests and diseases which have been previously introduced or are indigenous. Moreover, important as some plant parasites have proved, several other factors such as the demand for better plant food for both animals and human beings, as well as other national and economic considerations make the importation of new plants not only desirable but also essential. In the past, botanical gardens have been established in various countries with a view to establishing a source of supply of successfully grown crop and ornamental plants. And there is no gainsaying that, although these gardens have admirably served this purpose in the past, the lack of adequate quarantine measures has resulted in their serving also as a ready source for the distribution of many pests and diseases.

The pioneers of plant quarantine work, at least within the British Empire, and probably in the world, have been the authorities of the Royal Botanic Gardens at Kew in England. Crop and ornamental plants have been collected at Kew from all parts of the world and it would be no exaggeration to say that, after a period of quarantine, such plants have been distributed almost equally widely. In addition to the quarantine facilities available at Kew it has become evident in recent years that other quarantine services and stations are necessary in order adequately to safeguard modern agricultural industries. Two such quarantine stations have recently been established in the Colonial Empire, namely, one at the Imperial College of Tropical Agriculture, and the other at the Amani Research Institute in Tanganyika. The Station in Trinidad serves the British West Indian possessions and the Central Quarantine Station at Amani will function for the colonies and mandated territory of East Africa.

In respect of protective measures against the distribution of plant pests and disease, group arrangements have been made between Canada and the United States, and between the Union of South Africa, Southern Rhodesia, Northern Rhodesia and the Belgian Congo. Proposals have also been made for uniform plant protective legislation for the West African Colonies.

On completion of the building of the Plant Quarantine Station for the British West Indian Colonies the Plant Quarantine Committee decided that it was desirable for its secretary to visit Washington, with a view to formulating a scheme of co-operation whereby an exchange of plant material, which had been passed through the respective quarantine stations, could be made between the British West Indies and the United States Department of Agriculture with the minimum possible danger of introducing diseases and pests into either territory. As a result of this visit relations have been placed on an excellent footing and there is no doubt that this example will be followed by other countries and that the fight against economic plant diseases and pests will be sanely viewed as an international problem which requires close international co-operation and surveillance.

AGRICULTURAL LABOUR IN TRINIDAD.

BY

C. Y. SHEPHARD.

A series of notes on Agricultural Labour in Trinidad was prepared in 1929 for the information of planters. Portions of these notes are published by request. Certain tables have been brought up-to-date, but otherwise the articles remain unaltered.

Historical Introduction.

I. 1498-1797. UNDER THE SPANIARDS.

TRINIDAD was discovered by Columbus in 1498 and remained in Spanish possession for about 300 years. The Spaniards first came to the New World in a spirit of adventure, infused with the hope of discovering treasure. The islands and the mainland were explored and the wealth of the Indians, particularly of Mexico and Peru, tapped. The gradual exhaustion of these accumulated stores led to the working of mines for gold and silver, and of fisheries for pearls. Labour was required, and was secured by slave raiding amongst the Indians of the larger islands and the Main. Trinidad having been sought unsuccessfully by conquest was used as a source of slaves for the pearl fisheries of Cubagua and Margarita. This period was ended by the publication of the New Laws for the Indies which established the fundamental principle that Indians were free men, and ended the presumption that they were incapable of Christian salvation and thus fit only for slavery. A new empire had been staked out by the occupation of coasts, tablelands, and interior outposts.

During the next fifty years the wave of expansion spent itself and an era of consolidation and administration ensued. Each Commander or Adelantado in his explorations and conquests was assigned two tasks: the reduction, conversion and preservation of the Indians, and the founding of Spanish towns. This period in Trinidad dates from 1591 when Antonio de Berrio, profiting by the violent conflicts between the Arawaks and Caribs, established a permanent government at St. Joseph. The administrative system in Trinidad, following that of other parts of the Spanish colonial empire, included the "encomienda" or the grant of Indian settlements to Spaniards, who were required to protect the Indians and provide Christian instruction, and whose reward consisted of a fixed tribute or task of labour. This formed the basis of the first agricultural development in Spanish times. Within thirty years English and Dutch called frequently at Trinidad to trade in the principal crop, tobacco, the quality of which was referred to in eulogistic terms by English writers of the period.

This trade with foreign ships and towns was contrary to the rigid system restricting all trade to Spanish ships and to the towns of Seville, and, later, Cadiz. A special Commissioner was despatched to Trinidad to reprimand the inhabitants and dismiss the Governor. Spanish ships were few in number and, being more liable to capture, their freight rates were seven to eight times as great as in the English ships, and with the diminished contraband trade tobacco cultivation in Trinidad declined. For many years French, English, and Dutch ships had frequented West Indian waters and from 1600 in Guiana, and 1625 in the islands, these nations began to effect more permanent settlements. With this growing strength, attacks were made on the Spanish colonies, and between 1594 and 1674 Trinidad suffered from at least five serious raids which further hindered development. The export of tobacco and sugar from foreign islands rendered successful commerce with Trinidad even more remote.

The cacao plant was introduced into Trinidad from the Main about 1670 and, as it was not cultivated in the neighbouring foreign settlements, stood a better chance of finding a remunerative market. The impetus it gave to agricultural development gave rise to demands for additional labour. In the meantime the "encomiendas" were gradually being withdrawn all over the Spanish colonial empire, and the control of the Indians was passing into the hands of the missionary priests. It was not until 1687 that the missions had been successfully developed in Trinidad, but with the collection of Indians into settled centres, the Spaniards wished the Indians to be sent as labourers into the cacao fields in return for pay, food, and instruction in Christianity. The planters failed to carry out their promises and after periods of about six to eight months the Indians returned exhausted, sick with hunger, untaught and unpaid. The missionaries incurred the opposition of the planters by refusing to continue these arrangements and, in spite of the support of the Governor, they were required by the Royal Cedula of 1708 to leave the island and hand over the missions to the regular clergy. This, however, failed to solve the labour problem because the Indians promptly deserted the missions and took to the mountains.

Probably about this time Trinidad began to rely on negro slave labour. In 1606 a Dutch merchant had delivered a special shipment of 470 negroes to rebuild the destroyed settlements at St. Joseph, but there is no known record indicating subsequent importations, and it is unlikely that any occurred until the development of cacao overtook the labour obtainable from the native tribes. The Asiento de Negros was awarded to the French Guinea Company in 1701, and to the English South Sea Company in 1713, and it is probable that a supply of slaves became more easily and regularly available. At all

events cacao cultivation expanded into a lucrative industry, aided probably by the greatly increased contraband trade that flourished under cover of the slave trade. In 1727 the cacao industry was destroyed by a "blast", the exact nature of which is unknown, and the planters and their slaves were compelled to seek refuge on the mainland, the population, exclusive of Indians, dwindling to 162 adults of whom only 28 were white (10). After such wholesale abandonment recovery was tedious and difficult and even the belated relaxation of the trade restrictions between 1764 and 1788 provoked little response.

The visit of M. Laurent, a Frenchman from Grenada, in 1777, led after prolonged negotiations, to the Cedula of 1783, which gave the first real impetus to the economic development of the Colony. The Cedula offered to white Catholics 32 acres of land, with 16 acres for each slave owned, and half these quantities to free coloured Catholics and their slaves. New settlers were afforded relief from taxation, and animals and agricultural implements were to be imported at cost and free of duty. Trade with the French islands was permitted under special regulations (9).

These generous measures were liberally interpreted and French immigrants, flocked with their slaves from the islands of St. Vincent, Martinique, Guadeloupe, Dominica, and, in particular, Grenada. With the spread of the revolutionary principles to the French islands the Royalist planters of Santo Domingo and Martinique sought refuge in Trinidad, followed by French free people of colour, and later, with the capture of the French islands by the English, by revolutionary refugees.

In general the Cedula of 1783 resulted in populating this Spanish colony with French subjects, in placing a premium upon the importation of slaves, and in the rapid development of agriculture, including the introduction of the sugar industry into the Naparimas. Between 1783 and 1797 the population, excluding Indians, increased from less than 1,000 to more than 16,000 of whom 2,000 were whites, 4,500 free coloured, and 10,000 slaves. The native Indians numbered 1,000. In 1797 the island is said to have contained 468 estates, of which 159 were devoted to sugar, 130 to coffee, 103 to cotton, 70 to tobacco and 6 to cacao, in addition to several indigo and young cacao plantations (9). The total cultivated area was estimated at 36,000 acres, though, from the laborious nature of the crops and the small population, it is evident that the plantations were small in size and the system of cultivation extensive.

II. 1797-1845. Labour Difficulties under the British.

The peculiar situation of a Spanish colony populated mainly by, and ruled principally with the assistance of, the French, was, however, short-lived, owing to the out-break of war between England and Spain and the capture of the Colony by a powerful English expedition. Between 1797 and 1803 (when Trinidad was formally ceded to the British) the island was ruled with a firm hand. The population rose to 29,000 on account of the importation of 11,000 slaves, whose total numbers rose to 21,000 (12). The sugar industry expanded rapidly, the production rising from 8,000 hogsheads* in 1797 to 15,000 hogsheads in 1802, while cacao, coffee and cotton also increased slightly (8).

It will be seen that for nearly three hundred years Spain had done little to stimulate agricultural industries in the island and the small development which had taken place subsequent to 1783 was due to French colonists. Trinidad is distinguished from the other British West Indian islands by its late acquisition and the lack of agricultural development prior to the nineteenth century.

With the Treaty of Amiens, Scotch and English adventurers flocked from the islands which had temporarily been in British hands. Rapid development awaited an increase of population. To augment the supply of labour longer hours of work were exacted from the slaves, while their free days were reduced from 134 per annum to 69 (12). Trinidad soon earned the reputation of having the greatest production of sugar per head of population and the heaviest mortality in the British West Indies. During the first few years the energies and resources of the planters were devoted chiefly to clearing the land and erecting sugar works. The abolition of the slave trade in 1807 made it difficult for them to secure the labour necessary for the production of sugar. Only about 1,000 slaves had been introduced by traders, the majority having been brought by their masters, or introduced clandestinely, from neighbouring islands. In the older British West Indian islands there was said to have been an average of one slave to every acre of cultivation, whereas in Trinidad there was only one slave to every seven acres occupied. Even the transfer of slaves from the more densely populated islands to Trinidad was prohibited (5), and the planters found it impossible to cultivate the whole of the extensive areas they had occupied.

The difficulties of the planters were heightened by an enquiry concerning land titles. Some grants had been made prior to the Cedula of 1783, others as a result of the Cedula, still others during the occupancy of the British between 1797 and 1803, and, finally, others after 1803, but few planters possessed complete legal titles. The confusion was complicated by the fact that many sales of land had taken place for which no one possessed a valid title. By a Proclamation of December, 1815, it was required that at least one-fifth of the lands granted should be under cultivation, and that a number of labourers varying with the size of the estate (9) should be maintained. The Governor threatened to resume land not fulfilling these conditions, but the planters complained that the abolition of the slave trade had made such compliance impossible

* 1 hogshead=about 15 cwt.

Their titles being questioned the planters found it extremely difficult to secure credit from English merchants, and it was not until a commission from England had settled the question, after considerable litigation, to the satisfaction of the colonists, that confidence was restored. The progressive amelioration of the conditions of slavery (16) led to the introduction of task work, as contrasted with day work, as an incentive to industry.

The introduction of the system of apprenticeship on 31st August, 1834 added still further to the difficulties of the planters. The negroes were unable to appreciate the subtle difference between slavery and apprenticeship, or the distinction between praedial and non-praedial apprenticeship, and manifested their discontent by refusing to work. The ringleaders were punished and order was restored, but passive resistance continued. On 1st August, 1838 all apprentices were granted complete freedom. No comprehensive policy had been adopted to prepare the apprentices for the responsibilities of freedom. They exhibited a strong aversion to work as agricultural labourers, and flocked to the towns or villages as artisans and petty traders, or squatted on Crown Lands. To compel the emancipated slaves to work on the estates an attempt was made to prevent squatting while the acquisition of land was made practically impossible (15). The former practice of Commandants of Quarters in giving written permits for the occupation of Crown Lands, without specifying the boundaries, made it impossible to distinguish the authorised from the unauthorised squatters whose numbers consequently increased.

Compensation amounting to £1,039,000 (8), which was paid to the slave owners in Trinidad, was principally utilised for the purpose of liquidating mortgages. This enabled the planters to begin the new period free of debt, while a rise in the price of sugar enabled them to increase the rates of task work. Immediately after Emancipation wages varied between 20 cents and 30 cents a day, but by 1841 they had risen to 50 cents per task for resident labourers, with allowances of food, housing and provision grounds, and 60 cents for non-resident labourers. A task could be completed in about four hours, and some exceptionally industrious labourers occasionally succeeded in completing three tasks in a day (5). In spite of these high wages, labour difficulties continued. The labourers found that by working two or three days a week they could earn sufficient to satisfy their wants. Planters found it impossible to reap the whole of their crops and they were sometimes compelled to allow canes to 'standover' until the next crop.

Frantic attempts were made to remedy the shortage of labour by 'voluntary immigration' from a variety of sources. As early as 1806 a few Chinese had been introduced but the experiment was a complete failure (10). Some 4,000 Africans captured from foreign slave traders, and liberated by the British squadron off the Guinea Coast, were brought to Trinidad (9). A few immigrants from Madeira and Brazil came in 1835 but they proved such easy victims to disease that this uncontrolled experiment was discontinued (6). Following the example of Mauritius (22) a small number of East Indians were recruited in 1838 but the alleged abuses of this "new species of slave trade" led to its speedy termination by the Government of India (6). Attracted by the high rates of wages, labourers were introduced, at the expense of the Colonial Treasury, from the smaller and more populated West Indian islands (5), the United States of America, Malta and Germany (4), but the negroes immediately associated themselves with the emancipated slaves, while the whites proved incapable of labouring continuously under tropical conditions. In 1838 an Order in Council declared invalid any labour contracts, exceeding one month, executed outside the Colony (4). Exports of sugar which had risen to an average of 21,000 hogsheads from 1832 to 1838, fell to 16,000 hogsheads in 1839 (9). The situation was critical, and it became clear that the existence of the sugar industry depended upon "the immigration of a fresh labouring population to such an extent as to create competition for employment" (20).

To relieve the situation the British Government began, in 1841, to introduce Africans from the Kroo coast, but the system was so carefully hedged with safeguards that after the first two years their numbers were not appreciable. The West India Committee petitioned for the recruitment of contract labourers from Africa, India and China, and after prolonged negotiations licences were actually issued for the introduction of Chinese coolies into Trinidad (6). The immediate need for Chinese immigration was, however, removed by the permission given for the importation, under Government control, of labourers from India under contract for periods of not less than three years. The first of these immigrants arrived in 1845 and satisfactory arrangements were also made for the introduction of labourers from Madeira. It appeared that the labour difficulties of the planters would, rapidly, be solved.

Almost immediately, however, the island was involved in a second and even more serious crisis. Emancipation led to a rapid rise in the cost of sugar production in the British Colonies but slavery was continued in the competing islands. A tariff levied by the United Kingdom against slave produced sugar enabled the British producers to compete, with a declining measure of success, against their foreign rivals. 'Free trade' followed hard on the heels of Emancipation and by the Sugar Act of 1846 the duties on foreign and colonial sugar were equalised. This, emphasised by a prolonged drought, resulted in a collapse of the island's sugar industry (8), and it again became painfully evident that, without an adequate supply of cheap labour, the sugar industry could no longer survive in competition with foreign sugar. The East Indians, recruited during the previous year, came from the streets and bazaars of Indian cities and, unused to

agriculture, and disillusioned by the promises of the recruiters, they wandered about the country, begging or stealing when the opportunity offered, and working only when necessity compelled. The disciplinary measures of the estate managers aroused the opposition of the vigilant Anti-Slavery Society. These unfortunate experiences demonstrated that, without elaborate precautions, East Indian immigration must inevitably result in failure. By ordinances of 1847 and 1848 the mutual obligations of employer and employed with regard to medical attendance, the period of indenture, which was fixed at three years, the obligation to work, and the right to a return passage, were more clearly defined. These amendments, however, proved belated, for the Anti-Slavery Society had already secured the cessation of Indian immigration and this ban continued during 1849 and 1850. In the meantime the Africans introduced by the British Government during 1841 and subsequent years, were insisting upon their right to a return passage. A frightful famine in Madeira caused the exodus of a large number of labourers to the West Indies and British Guiana, but debilitated by privation, and unaccustomed to the climate, many rapidly succumbed, while others became petty traders.

III. 1846-1921. Indentured Immigration.

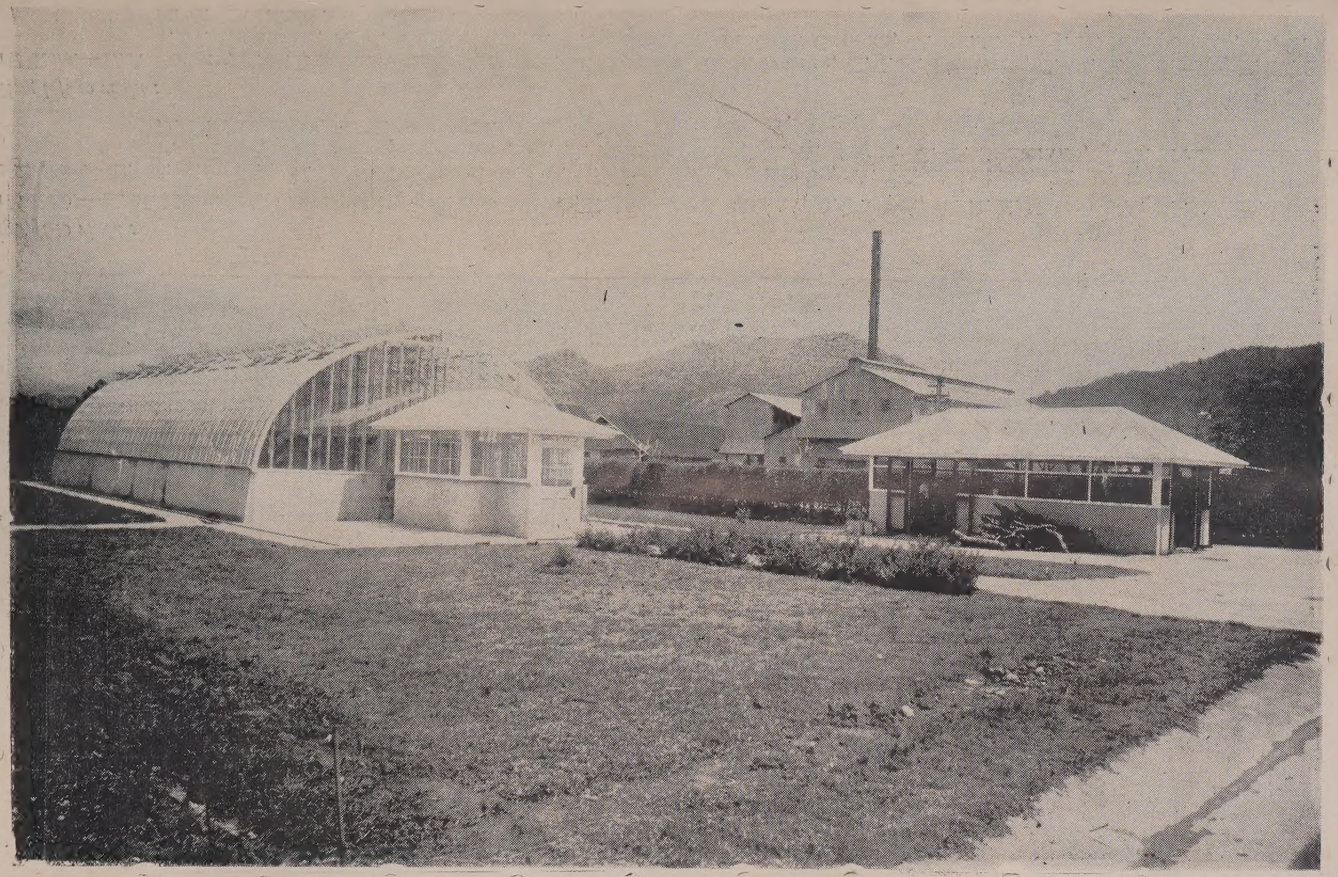
In desperation the planters again turned to the Far East where the impoverishment of Southern China was causing an extensive emigration. Permission was granted in 1850 for the immigration of Chinese coolies by private enterprise, under a Bounty System, and 990 were landed in Trinidad during the first season (6). The experiment was not very successful owing to the social difficulties of the purely male character of this emigration, the language bar, and the aversion of the Chinese to European medical methods. The abuses of the speculative competition between European nations for Chinese coolies threatened to interfere seriously with other trade and it was agreed that emigration to the British West Indies should be conducted by Government officials. The obstacles proved so formidable that Chinese immigration was discontinued until 1859. In the meantime immigration from India had recommenced under more satisfactory regulations, the interests of the labourers being safeguarded by a Government official, the Protector of Immigrants. At last the problem of securing an adequate supply of labour had been solved, for the planters were able by the payment of certain fees, and the observance of certain conditions, to secure as many labourers as they required. Interest in alternative sources of labour immediately subsided. Between 1843 and 1875 some 84,731 immigrants were introduced into Trinidad of whom 68,662 were East Indians, 2,645 Chinese, 6,375 Africans, and 6,105 West Indians, while 944 came from other sources.

With the annual influx of indentured East Indian labourers, agricultural development proceeded at an accelerating rate, and a moderate degree of prosperity was restored. Sugar exports rose from 20,000 tons in 1850 to 67,000 tons in 1879, cacao exports from less than four million lb. in 1850 to nearly 12 million lb. in 1897, while the population had increased from 43,000 in 1825, to 153,000 in 1881 (23).

The rise of a prosperous peasantry, whose production swelled the exports of the Colony, was made possible by the solution of the problem of squatting, which at intervals had caused the Government considerable anxiety. With the object of maintaining the labour force of the staple industries, Crown Lands were seldom alienated in small areas prior to 1847. In that year the price was fixed at £2 per acre with the deliberate intention of making purchase by labourers impossible. Squatting was particularly prevalent in the district of Montserrat where a survey in 1867 revealed 400 squatters, mainly Spanish peons, holding areas of cacao, coffee and provisions varying between 3 and 120 acres (11). It was decided to deal with the matter experimentally and in 1869 the price of Crown Lands was reduced to £1 per acre and Montserrat declared a ward. The squatters were allowed six months in which to petition for their land. The merchants in Port-of-Spain, upon whom the squatters depended for supplies and advances, willingly advanced the purchase money, on mortgage, since it assured them of the continued supply of produce (8). In this way the problem of squatting was speedily settled, only two squatters being evicted, and the experiment was successfully extended to other districts. These measures gave the first real impetus to peasant proprietary.

Soon white settlers, particularly those of French ancestry, began to penetrate into Montserrat, where they purchased small areas under cacao from the Spanish peons. Peasants, usually of Spanish extraction, were engaged as "cacao contractors" (2) to clear portions of Crown Lands, plant the area in cacao and bring it into bearing. At the conclusion of the contracts, which usually lasted five years, the peasants were paid a rate which varied between 15 cents and 25 cents for each full bearing tree. With this sum of money they were able to purchase other areas of Crown Lands and establish cacao holdings of their own. The planters, who were usually people of moderate resources, were able to pay the contractor by means of mortgages raised on these mature areas of cacao. Most of the cacao estates in Trinidad have been built up on the contract system and by means of mortgages, while many of the peasant holdings have been established by former "cacao contractors". In the eighties roads were constructed throughout Montserrat and the district rapidly opened up. The small holdings of the Spanish peasants were then of an age at which maximum yields are obtained and were sold in consequence at very high valuations. The non-gregarious habits and the foreclosure of mortgages were contributory factors to the movement of these Spaniards into

PLANT QUARANTINE STATION.



Exterior view of Plant Quarantine Station Buildings, at the Imperial College of Tropical Agriculture, Trinidad, B.W.I. These consist of a glass structure with an inspection chamber and (on the right) a potting shed equipped with a soil sterilizer.

IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

ACADEMIC STAFF AND STUDENTS, 1934-35.

Sitting left to right :

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2nd Row.—P. E. Turner, C. W. Wardlaw, F. W. Urich, J. R. Dickson, A. M. Adamson, E. E. Cheesman, R. C. Wood, F. Hardy, Sir Geoffrey Evans, H. R. Briton-Jones, G. A. Jones, C. Y. Shephard, J. G. Myers, C. C. Skeete, D. D. Paterson, G. G. Gianetti.

Standing left to right :

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the undeveloped areas of Tamana, Manzanilla, and other wards, where they again acted as the pioneers of the cacao industry.

Hitherto indentured immigrants had been recruited solely for the sugar industry, but the cacao planters in the Montserrat area successfully petitioned for indentured immigrants, the difficulty of complying with the medical requirements of the Immigration Ordinance being overcome, where necessary, by the grouping of estates for this purpose. The depression in the sugar industry towards the end of the century, and the relatively high prices of cacao, led to a very rapid expansion of the cacao industry. The area under cacao rose from about 7,000 acres in 1856 to 24,000 acres in 1879, and 354,000* acres in 1915, planting being particularly active during the closing years of nineteenth century, and the first fifteen years of the twentieth century. Cacao soon surpassed sugar as the major agricultural industry both in export value and acreage. Although the cacao industry has existed in Trinidad for over two hundred years its development has been largely confined to the past fifty years (16).

EXPORTS OF CACAO FROM TRINIDAD 1801-1888 AND TRINIDAD AND TOBAGO 1889-1930 (10 YEARS AVERAGE) (19).

	LB.
1801-10	491,356
1811-20	1,215,147
1821-30	2,447,418
1831-40	2,683,888
1841-50	3,416,045
1851-60	4,781,640
1861-70	6,562,463
1871-80	8,858,742
1881-90	14,815,084
1891-1900	24,267,666
1901-10	42,893,637
1911-20	56,292,213
1921-30	57,518,058

The sugar industry in the meantime was passing through a period of severe depression. The European beet sugar industry, aided by protective tariffs and bounties, and organised in cartels and trusts, began to undersell British West Indian cane sugar in the English market. In 1896 the price of sugar had fallen to half that of 1881, and in spite of the consolidation of factories, the improvements in machinery, the replacement of private individuals by companies, and the reduction of wages, heavy losses were still incurred. A serious outbreak of cane disease which spread with amazing rapidity and intensity throughout the islands, and occasioned heavy losses of cane, brought the industry to the verge of collapse. As the indirect result of a Royal Commission of Enquiry, the Bounty System was abolished by the Brussels Convention of 1902, and temporary assistance was given in the form of an Imperial grant of £250,000 to the West Indian sugar producers. An era of renewed prosperity was confidently anticipated but the reciprocity treaty of 1903, between the United States of America and Cuba, gave such an impetus to the latter's sugar industry that British West Indian sugar was not only completely shut out of the American market, but has also had, during recent years, to face increasing competition in the United Kingdom market. Production diminished slowly but steadily until the outbreak of the war when, under the stimulus of high prices, production rapidly increased (18).

Owing to the difficulty of securing adequate capital for carrying on estate cultivation, and with the additional object of persuading East Indians, whose periods of indenture had expired, to remain in the island, the sugar estates began, in the nineties, to encourage the production of cane by peasants for sale to the factory. The experiment proved successful, and was so stimulated by the high prices prevailing during the war, that today these cane farmers produce about two-fifths of the total cane supply.

IV. 1921-1924.—THE POST WAR DEPRESSION.

In 1921 both the sugar and cacao industries were involved in the world wide economic depression. The sugar companies with their wider financial resources, coupled with the necessity of continuous cultivation, were able to survive this period more easily than the cacao estates, though expenditure was heavily curtailed and difficulty was experienced in providing sufficient employment for the labourers. The effect on the cacao industry was disastrous for on many estates money had been recklessly borrowed on mortgage at the fictitiously high values which ruled during, and immediately after, the war. Cultivation was neglected and operations restricted to those absolutely imperative, in spite of which many planters found it impossible to meet the annual interest charges upon their mortgages. To prevent the wholesale transfer of cacao properties the Government found it necessary to introduce the Mortgages Extension Ordinance (14) which prevented mortgagees from foreclosing before June, 1923, provided the interest was not more than six months in arrears. The Agricultural Relief Ordinance (3) authorised the Government to make advances to the cacao estate owners. It was found necessary to continue these provisions (14) until 31st March, 1925, by which time the worst period of depression had passed. Loans are now made by the Government on mortgage through its Agricultural Bank. (1)

To meet the lower price levels the sugar estates attempted to reduce their costs of production by increasing their output of sugar, and improving their methods of sugar and cane production. This involved an additional demand for labour which was not, however, proportional to the increase in the output of sugar. During the slump

* This figure, extracted from the Blue Book, is exaggerated. In 1917 the area was recorded as 232,000 acres. In the meantime exports were increasing, and prices were good, averaging $15 per fanega (110 lb.) so that there is no reason to suppose that 120,000 acres were cut down.

in cacao prices some estates were abandoned, while others, on the edge of the sugar belt, were converted to sugar-cane. Many of the remaining estates planted coffee in their cacao fields as a subsidiary and more profitable crop. For several years, then, during the slump, the demand for agricultural labour, particularly by the cacao estates, was greatly reduced. The demand for labour in those occupations dependent upon agriculture as well as in most of the independent industries, was similarly curtailed, but with the return to higher levels of prices the demands for labour sympathetically expanded.

V. 1925–1929.—The Shortage of Agricultural Labour.

In the meantime, however, indentured immigration had ceased (1917), while repatriation continued, so that there was, on this account, a net loss of over 9,000 East Indians, many of whom had been engaged in agriculture. In addition there was a rapid expansion in the numbers employed in the oil industry. Prior to 1918 the numbers employed averaged less than 1,500 but in 1927 they rose to over 5,000 (13), and not only was the number in normal production work increased, but there was also a very large number engaged in constructional work, both directly by the oil companies and indirectly by the contractors they engaged. There was a decrease in the number of agricultural labourers, and an increased demand for labourers, not only by agricultural industries, but also by other industries and occupations. Complaints of an acute shortage of labour came from planters in nearly all districts of the Island.

VI. 1930–1934.—The Shortage of Agricultural Employment.

The fall in the prices of cacao and sugar has completely reversed the situation. Work has been curtailed, wages reduced, and tasks increased. The amount of labour available has been augmented by the reduced cultivation undertaken by peasant proprietors on their holdings. With the exception of short periods of exceptional activity, such as during the reaping season, planters have experienced great difficulty in providing employment. Government has attempted to ameliorate the situation by the provision of loans to sugar (21) and cacao planters (7) to enable them to continue the cultivation of their estates. The almost complete dependence of the agricultural community upon export crops renders it particularly susceptible to the variations in prices which are caused by factors beyond its control. Within a few years Trinidad has passed from a shortage of labour to a shortage of employment.

Summary.

I. 1492-1797.—Although the Spaniards discovered Trinidad in 1492 they were so obsessed with their quest of the Dorado that they neglected the agricultural potentialities of the island and utilised it merely as a source of slaves.

Tentative efforts, hindered by foreign attacks and internal dissension, were subsequently made to establish a cacao industry, but it was not until 1783 that the Cedula of Population gave the first real impetus to agriculture.

Within a few years the sugar industry had been introduced and the island populated by French subjects with whose assistance, principally, the island was governed and developed.

II. 1797-1846.—With the advent of the British the colony almost immediately began to experience a shortage of labour, for the abolition of the slave trade was followed by the apprenticeship system and, finally, by the emancipation of the slaves.

The withdrawal of the differential duty against slave produced sugar made an adequate supply of cheap labour imperative.

III. 1846-1921.—After many abortive attempts to recruit labourers from a variety of sources, arrangements were eventually made for the immigration of indentured labourers from India, by whose aid the agricultural industries of the island were rapidly developed.

The depression in the sugar industry, caused by the competition of bounty-fed beet sugar, diverted new capital and labour to the expansion of the cacao industry.

IV. 1921-1924.—The cessation of indentured immigration was not immediately felt owing to the post war slump, when estate expenditure was curtailed to such an extent that difficulty was experienced in providing employment for the labourers.

V. 1925-1929.—A recovery in prices led to an extended demand for agricultural labour while, in the meantime, the repatriation of East Indians reduced the number of labourers available. These factors were intensified by the increasing labour demands of other industries and occupations with the result that a shortage of agricultural labour was experienced.

VI. 1929-1934.—The fall in the prices of the principal crops has completely changed the situation from a shortage of labour to a shortage of employment.

Literature cited.

1. Agricultural Bank. Ordinance No. 12 of 1924, amended by Nos. 6 of 1927, 15 of 1927, 22 of 1928, 14 of 1929 and 31 of 1931.
2. Agricultural Contracts Ordinance, 1889.
3. Agricultural Relief Ordinances No. 66 of 1921, amended by Nos. 6 of 1922, 16 of 1923, 3 of 1924 and 24 of 1924.
4. British Guiana. Handbook. "Argosy Co.", British Guiana, 1909.
5. Burnley: *Observations on the present condition of the Island of Trinidad*, Longman, Brown, Green & Longmans 1842.
6. Campbell: *Chinese Coolie Emigration*, P. S. King & Son 1923.
7. Cocoa Industry Relief. Ordinance No. 36 of 1930, amended by No. 24 of 1932.
8. De Verteuil: *Trinidad*, Ward & Lock, 1858.
9. Fraser: *History of Trinidad*, Vols. 1 & 2. Government Printing Office, Trinidad, 1896.
10. Joseph: *History of Trinidad* 1838.

11. Kingsley: *At Last*, Macmillan, New York, 1889.
12. Mathieson: *British Slavery and its Abolition*, 1823-1838. Longmans Green & Co. 1926.
13. Mines. Council Paper No. 66 of 1928.
14. Mortgages Extension. Ordinance No. 65 of 1921, repealed and replaced by No. 1 of 1922, amended by Nos. 17 of 1923 and 14 of 1924.
15. Order in Council. 1838.
16. Parliamentary Papers. 1825. Vol. XXVI.
17. Shephard: *An Economic Survey of the Cacao Industry of Trinidad*. Economic Geography, Vol. III, No. 2.
18. Shephard: *An Economic Survey of the Sugar Industry of the British West Indies and British Guiana*. Economic Geography, Vol. V, No. 2.
19. Shephard: *Exports of Cacao from Trinidad*, 1797 to 1931. Proceedings of the Agricultural Society of Trinidad and Tobago, March, 1932.
20. Stanley's (Lord) Select Committee 1842.
21. Sugar Industry Relief. Ordinance No. 15 of 1930.
22. Walter: *The Sugar Industry of Mauritius*, Humphreys, 1910.
23. West Indian Royal Commission, C. 8655, 1897.

REVIEW.

Gardening in East Africa.

A Practical Handbook by Members of the Kenya Horticultural Society and of the Kenya and Uganda Civil Services. Edited by A. J. Jex-Blake. With a foreword by Sir Arthur W. Hill, K.C.M.G., F.R.S. *Longmans, Green & Co.*, London, New York, Toronto 1934. Price: 12*s.* 6*d.*

To study culture, and with artful toil
To 'meliorate and tame the stubborn soil;
To give dissimilar yet fruitful lands
The grain, the herb, the plant that each demands.

Cowper.

Books on gardening in the tropics and sub-tropics are so scarce that the authors of this book have put gardeners deeply in their debt by this eminently practical volume to which a delightful foreword is contributed by Sir Arthur Hill.

The book is divided into twenty chapters, written by members of the Kenya Horticultural Society and of the Kenya and Uganda Civil Services, and is edited by Dr. A. J. Jex-Blake. As Sir Arthur Hill says—"It will naturally be a book of great value to those going out to Kenya, teaching them beforehand what to do and what to avoid: while to gardeners at home, who may be anxious—as so many fortunately are—to help their horticultural friends in distant parts of the Empire, it will be most useful, for the book is so well written and so comprehensive, that much of it is applicable to other parts of the tropical and sub-tropical colonies and dominions".

It may be said at the outset that all the chapters are good, though the three opening chapters on climate, soil, and manuring are especially valuable. The scope of the work is as great as the climatic variability with which it deals.

When it is remembered that the authors discuss horticulture over a range of climates from tropical lowlands to altitudes of 8,000 feet and over, embracing the culture of such diverse plants as apples and primroses on the one hand, and *Anthurium crystallinum* on the other, the magnitude of their task will be appreciated.

Now there are many keen gardeners scattered throughout the tropics and sub-tropics who will eagerly scan this book for information that will help them. What will strike the West Indian gardener most are the number of plants successfully grown at high altitudes which it is quite useless to attempt to grow in tropical lowlands. It is delightful to think of primroses in the tropics—"At 8,000 feet the primrose flourishes as it does in the woods of England" says Miss O. Collyer. At this, we in Trinidad murmur to ourselves—

I would I had some flowers o' the Spring that might become your time of day.

Winter's Tale.

While we envy the variety of climatic conditions available in East Africa, we also envy the beautiful indigenous plants described in Chapter XII by Mr. H. M. Gardner. Most of these however appear to be more suitable to high altitudes than to the lowlands.

The chapter on roses will rather stagger the gardener who has tropical conditions to contend with. The question of varieties is simply and briefly settled by the statement "all varieties of roses are likely to do equally well in any district". After this the statement that the greatest danger to rose trees in outlying parts of East Africa are the various species of buck elicits no surprise. In Trinidad it is the "black spot" disease, which unfortunately cannot be kept away from the roses by six feet of wire netting.

If it is not too presumptuous to advise such keen gardeners, one might suggest the extensive trial of some of the newer *Rosa gigantea* hybrids which have been so successful in the sub-tropics.

Some groups of plants such as ferns, orchids, and such plants as Anthurium, or Alocasia especially prized in the West Indies find only scant mention, and many of our palms seem to be unknown. This is doubtless due to the fact that horticulture in East Africa is relatively new. In the West Indies, we are particularly fortunate in that practically the whole resources of the tropics have been combed for our benefit, and we only wish that some of our really good things could be introduced into East Africa—some of the newer *Hibiscus rosa-sinensis* hybrids for example.

Reading the chapter on vegetables raises a minor point—the relatively little attention given to food crops indigenous to the tropics. In

tropical lowlands it is exceedingly difficult to provide a succession of northern vegetables the whole year round and one therefore has to fall back on indigenous species. There is a tendency to despise these as "native", but many of them if carefully cooked are as good as the European vegetables. The white variety of the pigeon pea (*Cajanus indicus*) for example provides a good substitute for the English pea, as does also the white Cowpea (*Para Pea*).

Corn (maize) is so extensively eaten by natives in Africa that the merits of Sweet Corn have been overlooked. Such valuable plants as the yam, dasheen, Dolichos, and Basella, are also not mentioned. A few notes on tropical vegetables would perhaps have added to the value of the book, as would a list of particular varieties of northern vegetables which have been found suitable to the tropics.

In the section on pests and diseases prevalent in Uganda, the hippopotamus is listed as a "major" pest. It is related that "a few years ago two hippos fought to death in the nursery at the Botanic Gardens, Entebbe; the one that was unlucky expired on a bed of seedlings—the seedlings were unlucky too".

In Chapter XVI—on tropical and sub-tropical fruits there is a statement on p. 225 in connection with citrus trees that should not be allowed to pass without comment. It is said that "crossing by bees may take place where trees of different varieties are growing as much as a mile apart. Such cross-fertilisation has often been noticed in other varieties grown on the same estate as Navel oranges: hence non-Navel oranges may reproduce the Navel peculiarity if Navel oranges are fruiting in the vicinity".

The snag here is that the Navel orange is a completely male sterile type and there is thus no possibility of this variety of orange affecting others in the vicinity.

One hopes that the horrible alternative "Pawpaw" instead of "Papaw" or "Papaya" will not become widespread. The cognomen "Pawpaw" more properly refers to the wholly unrelated North American species *Asimina triloba*. This, however, is quite a minor point and does not detract in any way from the book itself, which ought to be on the shelf of everybody in the tropics and sub-tropics who is interested in gardening.

S. C. HARLAND.

COTTON NOTES.

Budding and Grafting Trials with Cotton and Related Plants.*

This short paper describes budding and grafting trials between widely different species of *Gossypium*, and also between the genera *Gossypium*, *Thurberia*, *Paritium*, *Hibiscus*, *Thespesia*, and *Erioxylum*. The literature is briefly referred to though there seems a slight reluctance to deal with the subject historically. For instance, since Smith (1909) working in Hawaii was the first to demonstrate the practicability of budding cottons it seems a little unnecessary to quote *unpublished* later observations by other workers merely going over the same ground.

It may be mentioned that cotton was successfully grafted as early as 1871, for in the *Gardener's Chronicle* for that year p. 1260, is a figure of a grafted seedling, the scion being united to the stock just below the cotyledons.

Beckett found that *G. Sturtii* could be successfully budded on to *G. Davidsonii* and *G. arboreum*, and inarched with upland types of cotton from lower California and Siam. *Thurberia thespesioides* was budded on *G. arboreum* and *G. calycotum*, while *Erioxylum aridum* was budded on to *G. arboreum*. These results are all consistent with our knowledge of the taxonomy of the genus *Gossypium*, since on both cytological and genetical grounds it is the consensus of opinion at this Station that both *Erioxylum aridum* and *Thurberia thespesioides* are members of the genus *Gossypium*.

It may be mentioned that the practice of budding or grafting species of *Gossypium* on other species has been in common use at this Station since 1926, and although a few combinations have not been tried there is little doubt that all species of *Gossypium* intergraft with the greatest of ease.

Of greater interest is Beckett's pronouncement that *Paritium tiliaceum* (*Hibiscus tiliaceus*) and *Thespesia populnea* can be successfully inarched with *Gossypium* and also upon each other. Between 1926 and 1930 the intergrafting relationships of *Gossypium* to other genera in the *Hibisceae* were studied by the writer, but although a loose union was obtained between *Thespesia* and *Gossypium*, there was no evidence of any transference of nutrients from stock to scion. The scion could persist for several weeks in a green state but failed to make independent growth, when all branches were removed from the stock.

A photograph is presented in Beckett's paper of a plant of *G. Sturtii* carrying an inarched branch of *Thespesia populnea*, but the plant still has a branch of the stock *G. Sturtii*.

In considering the type of union between stock and scion all stages seem to be possible between a loose association of cells which permits water to pass from stock to scion but not nutrients necessary for growth, and a real biochemical union permitting normal growth and translocation of nutrients. In the opinion of the reviewer the term successful grafting should be confined to the latter type of union and if this delimitation be accepted, the question of whether success has been attained in grafting *Gossypium* with *Thespesia* or *Paritium* must be left open.

S. C. HARLAND.

* R. E. Beckett (1933) U. S. A. Department of Agriculture. Circular No. 267.

THE MINERAL NUTRITION OF PLANTS.

The Possible Application of Recent Ideas to the Growth and Manuring of the Cacao Tree.

By J. A. McDonald.

I.—Introduction.

During recent years a large number of investigations have been initiated to determine the rôle of the principal nutrient elements concerned in plant growth, and many experiments have been made to determine the optimum amounts and proportions of the different elements needed by different plant species. Although most of these investigations have concerned temperate crop plants, perhaps some of the more important findings may be directly applicable to tropical crops such as cacao.

During the past few years the chemical section of Cacao Research at the Imperial College of Tropical Agriculture has initiated several investigations on the nutrition of the cacao tree which have been based on the knowledge gained from researches on temperate crop plants. In the 1933 Cacao Research Report (1), the writer presented a brief review of the present state of knowledge with regard to mineral plant nutrition in which it was shown how modern ideas of nutrient balance might be applied to problems concerning the growth and manuring of the cacao tree. The different aspects of the problem were also discussed at some length and a full list of references to original researches was given. This note, which is based upon the above review, presents a short outline of the most recent ideas concerning plant nutrient supply, and the estimation of manurial ratios necessary for optimum growth and yield.

II.—The Rôle of the Principal Nutrient Elements in Plant Nutrition.

Cultivated plants under ordinary field conditions are affected to a far greater extent by changes in the nitrogen, phosphorus and potassium content of the soil than by that of any other element essential to plant growth. In the ensuing discussion therefore, the nutrient status of the soil with regard to these three elements only will be considered.

(*a*) Nitrogen.

Abundant supplies of nitrogen cause rapid vegetative development and increased leaf growth; this may have the effect of retarding the ripening of the crop, since vegetative activities are continued for a longer period. Excessive supplies of nitrogen lead to the development of large dark green leaves which are frequently soft and sappy and particularly liable to insect and fungus attack.

Crops grown for the sake of their vegetative portions are greatly improved by increased nitrogen supply, but with regard to fruit trees, excess of nitrogen may result in too much leaf growth and too little fruiting, as well as in many other harmful physiological effects. Hence the manurial requirements of contrasted tropical crops, such as sugar-cane and cacao will be fundamentally different.

T. Wallace of Long Ashton, England, has described the effects on fruit trees of the deficiency of various elements (2), (3), (5), (6). Deficiency of nitrogen is characterised by stunted growth, and a reduced number of leaves which are small and pale yellowish green in colour. Eventually fruit trees may carry foliage only at the tips of the branches and thus develop a characteristic bare wood appearance. Root systems are poorly developed and consist almost entirely of fine, fibrous rootlets.

(*b*) Potassium.

Potassium supply has been shown to have a large influence on the manufacture of carbohydrate by the leaf (8), (9), (10), (11), (12). Since carbohydrate manufacture also depends on light intensity, an adequate supply of potash is particularly desirable for plants growing under excessively shaded conditions, or in abnormally cloudy weather, when the amount of sunlight reaching the plant may be greatly reduced. In this respect potassium may be said to form a substitute for sunlight.

Potassium supply is also a factor concerned in controlling both the uptake and loss of water by the plant. Wallace (4), (5), has shown that potassium deficiency is a factor contributing to leaf scorch of fruit trees, which is a pathological condition induced by unsatisfactory water relations. Mann (13), has further shown that the potassium content of leaves exerts a controlling influence on the rate of transpiration under conditions of high temperature and bright sunshine. Plants adequately supplied with potassium are, therefore, more resistant to wide fluctuations in water supply. Potassium compounds which are essential for cell division accumulate in the meristematic tissues on actively growing portions of the plant.

Potassium deficiency in temperate fruit trees is characterised by a marginal browning of the leaves which may extend inwards between the veins as far as the mid-rib. The brownish-grey colour of the leaves gives them the appearance of having been scorched by fire. Potassium deficiency also leads to the die-back of vegetative shoots and to a greatly increased number of flower buds. Fruit yields are greatly reduced, for, although a large number of fruits is set, a large proportion is subsequently shed and those which eventually mature are small and shrivelled.

(*c*) Phosphorus.

Phosphorus supply has a marked effect on the development of the root systems of plants. Thus, phosphatic manures are considered particularly valuable on heavy clay soils where roots do not naturally grow vigorously, but they are less needed on sandy soils, because abundant root growth normally occurs on such soils. Phosphorus has also been shown to be a factor influencing the photo-synthetic activity of the leaf. An abundant phosphate supply appears to be particularly necessary for plants in the early stages of growth (14), (15). This general principle applies also to other nutrient elements; when plants are provided with an adequate and balanced nutrient supply during their early growth stages, they are better able to withstand adverse conditions in later life, and are able to utilise the less readily available nutrients in the soil.

Phosphate deficiency in temperate fruit trees is characterised by a reduction in the amount of foliage and in the size of individual leaves, which exhibit characteristic purple and bronze tints over their surfaces. Flower formation is greatly restricted owing to the death of lateral buds, and the quantitative yield of fruit is greatly reduced. Most of these features are similar to those due to nitrogen deficiency, but with regard to quality of fruit, phosphorus deficient fruits differ markedly from nitrogen deficient fruits. Their colour is dull with a suggestion of the bronzing which develops on the leaves, and their commercial qualities are wholly undesirable. The root systems of phosphorus deficient trees are small in size, but they differ markedly in character from those produced by nitrogen deficiency, consisting almost entirely of coarse roots, almost entirely devoid of fine fibrous rootlets.

(*d*) Possible Application to Problems Concerning the Growth of Cacao.

It is still a matter of conjecture how far the findings of Wallace and others with regard to temperate fruit trees may be applied to the cacao tree. These recent ideas concerning the individual effect of nutrient elements on plant growth are largely based on evidence obtained from carefully controlled sand and water cultures. The problem is more involved when the trees are growing under normal field conditions since the factors operating in the soil are more numerous and complex.

The investigations of Wallace at Long Ashton demonstrate that certain symptoms and certain habits of growth are associated with deficiencies of particular elements. Fruit trees exhibit markedly different growth characteristics depending upon whether potassium is deficient or whether nitrogen or phosphate is deficient. In the case of nitrogen or phosphate deficiency, relatively few flowers and fruits are produced. In the case of potassium deficiency, however, large numbers of flowers are produced, and large numbers of fruits are set, though a great proportion is subsequently lost by shedding. Such a condition is analogous to the frequently observed behaviour of the cacao tree, which flowers profusely and sets large numbers of fruits, but usually a considerable proportion of the young fruits shrivels on the trees and fails to mature. This behaviour of the cacao tree may be partially determined by potassium supply, either through its direct effect on the metabolism of the plant or indirectly through its effect on the assimilation of carbohydrate and the utilisation of nitrogen. This explanation is purely speculative, however, since no direct supporting evidence has yet been accumulated.

At first sight this hypothesis, that shrivelling of young cherelles on the cacao tree may be due to *potassium* deficiency is not reconcilable with the widespread deficiency of soil *phosphate* demonstrated by the soil surveys (16), (17), (18), carried out by the Chemistry Department of the Imperial College of Tropical Agriculture. The results of the recent investigations (1) of the Chemical Section of Cacao Research however, offer an explanation which may link up the two phenomena. The analysis of cacao leaves taken from plots receiving different manurial treatments has shown that the addition of phosphatic manures to a soil deficient in phosphate has resulted in an increased uptake of potash by the cacao tree. This suggests that where soil phosphate is deficient, the cacao tree may have some difficulty in obtaining adequate supplies of potash, thus the tree may show symptoms of potash deficiency which are directly due to phosphate deficiency in the soil.

III.—The Potassium/Nitrogen Ratio.

The individual growth effects of a particular element do not necessarily depend on its gross deficiency or abundance. A great many recent researches have shown that the effects vary considerably, depending on the proportion of the other elements present in the soil solution. In this connection there appears to be a particularly delicate balance between the two elements potassium and nitrogen.

Wallace, (2), (3), (4), (5), (6), has emphasized the importance of the potassium/nitrogen ratio in the growth of fruit trees. Leaf scorch of fruit trees, insufficiently supplied with potassium, increases with each increment of nitrogen in the nutrient solution. Bronzing of the leaves of citrus trees growing in nutrient solutions having a low potassium/nitrogen ratio has also been reported by Reed and Haas, (19). With regard to coffee, Camargo, (20) has shown that the addition of excess of potassium above a certain limit produces a marked decrease in yield when the nitrogen supply is kept constant. Furthermore, when the potassium supply is kept constant and nitrogen is diminished, a decrease in yield also follows.

Russell (21), has summarised the relationship between potassium and nitrogen supply as follows :—

"The effects of potassium starvation on the growing plant fall into two groups, according to the supply of nitrogen. With small supplies of nitrogen, the leaves are small and little carbohydrate is synthesized, but its proportion to the nitrogen compounds in the plant, which are also small, is not abnormal. The plant, is stunted and rather ashy grey in colour, its leaves tending to die prematurely. Otherwise the plant shows no striking abnormality, until fruit or seeding time, when both fruit and seed tend to be small in quantity, in size and in weight. With large supplies of nitrogen, on the other hand, the uptake of nitrogen is considerable ; the leaves are large but relatively inefficient owing to lack of potassium, and therefore produce less carbohydrates in proportion to their nitrogen compounds. There results therefore, an abnormal excess of nitrogen in the plant which leads to various undesirable effects, such as an increased susceptibility of the plant to disease : this condition can be alleviated by applying potassic manures. Potassium is thus the counterpart of nitrogen, which is associated with the size of the leaf ; the two nutrients are intimately linked in their action. / It is well recognised in practice that neither potassic nor nitrogenous fertiliser gives its full effect without adequate supplies of the other."

The accumulated evidence from these investigations indicates that plants may absorb nutrients in approximately the same proportion that they are present in the nutrient medium. Accordingly, if a particular element is present in the soil in excess of the amount required for physiological balance, that element may be absorbed by the plant in excess of its requirements. This "luxury consumption" may result in a disturbance of normal metabolism which may seriously affect growth and yield, but to an extent which largely depends on the identity of the particular element absorbed in excess. The elements nitrogen and potassium appear to be particularly related in this respect ; the presence of either in excess usually profoundly disturbs normal plant growth and depresses yield. On the other hand, phosphorus may be abundantly present, and may be absorbed even in great excess without noticeably affecting plant processes.

Possible Application to Problems Concerning the Growth of the Cacao Tree.

Recent investigations in Trinidad, (1), (22), have shown that the potassium/nitrogen ratio of the leaf may be of great signficance in diagnosing the nutrient requirements of the cacao tree. Chemical analysis has shown that cacao trees, particularly susceptible to Thrips attack, exhibit a low ratio of potassium to nitrogen in the leaf (22). In certain instances the application of phosphatic manures has resulted in an increased uptake of potash and in restoring the potassium/nitrogen ratio of the leaf to a more normal value. This change in the composition of the leaf due to manuring was associated with an increase in yield of the order of fifty per cent. These preliminary results suggest that the potassium/nitrogen ratio of cacao leaves may be a valuable index of available nutrient supply to the tree, and the chemical analysis of plant material may prove to be a valuable method of estimating the manurial requirements of the crop.

IV.—The Carbohydrate/Nitrogen Ratio in the Plant, and its Relation to Nutrient Supply.

It has been demonstrated by many plant physiologists, (23), (24), (25), that growth and reproduction in plants depends to a considerable extent on the relative proportion of carbohydrate and nitrogen occurring within the plant. When the value of the carbohydrate/nitrogen ratio is relatively small, vegetative activities seem to follow, but when the value is relatively large, reproduction takes place. Recently this relationship has been firmly established, and it is already accepted in most countries, though its precise application in the management of fruit trees in order to control their fruitfulness is still obscure. With regard to tropical crops such as cacao and citrus the manner in which the carbohydrate/nitrogen ratio may be influenced by pruning or nitrogenous manuring has been indicated by Cheesman, (26).

The relative amounts of carbohydrate and nitrogen present in the plant depend largely on the activities of leaves and roots respectively. Carbohydrate is essentially a product of leaf manufacture. On the other hand nitrogenous substances gain access to the plant through the roots, being absorbed by the root hairs from solution in water.

Light intensity is probably the chief factor influencing the manufacture of carbohydrate by the leaf, but the supply of mineral nutrients, particularly potassium, may also markedly influence this process.

The amount of nitrogen taken up by the plant depends partly on the ability of the soil to supply nitrogen and partly on soil moisture. If soil water is deficient, smaller quantities of the nitrogenous compounds in the soil are dissolved and absorbed by the roots. It is apparent therefore that the relative amounts of carbohydrate and nitrogen present in the plant will depend largely on weather conditions. If the weather is dry and sunny, soil moisture will be deficient and light intensity will be high, hence an accumulation of carbohydrate in the plant will take place. On the other hand, if the weather is wet and cloudy, soil moisture will be abundant and light intensity will be low, hence nitrogen will tend to accumulate in the plant.

In this connection Taylor (27) has recently drawn attention to the fundamental differences in manurial practices in the fruit orchards of England and of the United States of America.

In North America, where summer rainfall is small and light intensity is high, it appears that the leaves are able to store up vast quantities of carbohydrate, and in consequence fruit trees would be expected to respond to large dressings of nitrogenous manures. Actually this has been found to be the case. The application to the soil of quickly available forms of nitrogen has given more beneficial results than any other fertiliser treatment in the growing of fruit trees, whereas many tests have failed to demonstrate any general response to the application of potassic manures. On the other hand, in England, trees growing on a soil well supplied with summer moisture, and exposed to light of lower intensity, are more likely to exhibit greater root activity in absorbing nitrogenous substances, and to manufacture relatively less amounts of carbohydrates. Such trees, therefore, are more likely to respond to potash manures than to nitrogenous manures alone. Wallace, (5), (6), (7), at Long Ashton, has demonstrated that this is indeed the case. He concludes that "potassium deficiency is the most serious deficiency disease of fruit trees and has been of extremely frequent occurrence in the past". Wallace also points out that potassium deficiency must usually be considered in relation to nitrogen supply.

The relative proportions of nitrogen and potassium necessary for balanced nutrition of crop plants are evidently influenced by weather and general environmental conditions as well as by the nutrient supplying ability of the soil. The delicate balance between the two elements would appear to be closely connected with the balance between carbohydrate and nitrogen in the plant. In this connection Russell (21) states that "the effect of potassium in correcting the harmful action of excess of nitrogen is in part at any rate attributable to its effect in increasing the net production of sugar and starch in the leaf, thus restoring to more normal values the carbohydrate/nitrogen ratio which has been disturbed by excessive nitrogen supply".

Possible Application to Problems Concerning the Growth of the Cacao Tree.

How far these principles may be applied to a crop such as cacao growing under tropical conditions of high rainfall and high light intensity is still problematical, but the results of investigations conducted with other fruit trees at any rate imply that correct manurial practices may be influenced by factors other than soil conditions alone. Possibly different levels of nitrogen nutrition are required for cacao, depending on the degree of shading. Thus, fundamental differences may exist in the manurial ratios required for greatest growth and yield in contrasted areas such as Grenada and Trinidad, where cacao is grown without shade and with heavy shade respectively. Under West Indian climatic conditions considerable differences in the duration of bright sunshine occur from one year to another. During 1933 in Trinidad there were nearly 300 hours less bright sunshine than in 1930. The benefits obtained from a particular system of manuring might therefore vary considerably depending upon the season.

V.—The Idea of Physiological Balance with Respect to Soil Nutrients and Manures.

Recent researches carried out on the fruit trees of temperate regions have clearly demonstrated that the correct nutrition of crop plants is a highly complex problem, and special knowledge and methods are necessary for the correct diagnosis of manurial requirements. It is now recognised that for each plant species there exists a balanced nutrient solution from which normal absorption occurs and greatest growth and yield result. A departure from this balance, either through deficiency or excess, produces a disturbance of absorption relations which may exert definitely harmful effects on plant growth.

In these days of low prices for the produce of tropical crops, the use of artificial manures can only be possible if the maximum benefit is derived from the added manure. The elements nitrogen, phosphorus and potassium are commonly present in the soil in inadequate or unbalanced amounts, and one or more of these three elements may have to be applied in the form of manures if adequate crop yields are to be obtained. The individual growth effects of each one of these elements does not, however, depend solely on its gross deficiency or excess, the effects vary considerably depending on the proportion of the other elements present in the soil solution. From a practical point of view, therefore, full benefit cannot be expected from the application to the soil of haphazard or arbitrary manurial mixtures. For instance, it is a common practice, when using artificials, to apply to the soil a "complete" manure containing nitrogen, phosphorus and potassium in about equal proportions, irrespective of the requirements of the soil or crop in question. In certain cases, the presence of one or more of these expensive ingredients may be wasteful or even harmful, since they may be already present in the soil in adequate proportion, and the added quantities in the manure may give rise to an unbalanced nutrient supply to the plant. The application of manurial substances should be made in particular and specific ratios, depending upon the particular requirements of the soil and plant as shown by soil analysis, field manurial trials, pot tests and chemical analysis of plant material.

For the purpose of estimating manurial requirements the simple determination of nutrient deficiencies of a soil is not alone sufficient. Excess as well as deficiency of a particular element may result in decreased growth and yields. In this connection, there appears to be a particularly delicate balance between the two elements, potassium and nitrogen. While neither element will give its full beneficial effect without adequate supplies of the other, yet the presence of either in excess usually depresses growth and yields also. On the other hand, phosphate may be present and may be absorbed in considerable excess without exerting noticeably harmful effects.

Many of the recent findings with regard to temperate fruit trees may be directly applicable to problems concerning the growth and manuring of the cacao tree, and they have indicated lines along which researches have been directed. Soil surveys (16), (17), (18), carried out by the Department of Chemistry of the Imperial College of Tropical Agriculture have shown that there is a lack of balance in the low-yielding cacao soils of the British West Indies, a characteristic widespread deficiency of soil phosphate being indicated. In order to restore the nutrient balance of these soils, the immediate need is for the application of phosphatic manures. Field manurial trials (1) and pot tests (28) have so far confirmed the results of the soil surveys. Increases in yield of the order of 50 per cent. have been obtained from the application of phosphatic manures alone, while chemical analysis of cacao leaf material (1), taken from the manured plots has shown that phosphatic manuring has indeed resulted in a more balanced nutrient supply to the cacao tree. By means of such methods, which also apply to other crops, it is hoped eventually to obtain an accurate indication of the nutrient requirements of the cacao tree, and to elaborate reliable methods for estimating the nutrient status of the soil for the formulation of balanced manurial mixtures.

References.

(1) McDonald, J. A.—Third Annual Report on Cacao Research, 1933. (B) Chemical and Ecological Section, 1934, Trinidad, Imperial College of Tropical Agriculture.

(2) Wallace, T.—Experiments on the Manuring of Fruit Trees, I. *Journ. Pomol. and Hort. Sci.*, 1925, IV, pp. 1-24.

(3) Wallace, T.—Experiments on the Manuring of Fruit Trees, II. *Journ. Pomol. and Hort. Sci.*, 1925, V, pp. 1-33.

(4) Wallace, T.—Leaf Scorch on Fruit Trees. *Journ. Pomol. and Hort. Sci.*, 1928, VI, pp. 243 ; VII, p. 1.

(5) Wallace, T.—Some Effects of Deficiencies of Essential Elements on Fruit Trees. *Annals of App. Biology*, 1930, XVII, pp. 650.

(6) Wallace, T.—The Nutrition of Woody Plants. *Forestry*, 1932, pp. 9-26.

(7) Wallace, T. and Proebsting, E. L.—The Potassium Status of Soils and Fruit Plants in Some Cases of Potassium Deficiency. *Journ. Pomol. and Hort. Sci.*, 1933, XI, pp. 120-148.

(8) Gregory, F. G.—The Effect of Climatic Conditions on the Growth of Barley. *Ann. Bot.*, 1926, XL, pp. 126.

(9) Gregory, F. G. and Richards, F. J.—Physiological Studies in Plant Nutrition, I. The Effect of Manurial Deficiency on the Respiration and Assimilation Rate in Barley. *Ann. Bot.*, 1929, XLIII, pp. 119-161.

(10) Nightingale, G. T., Schermerhorn, L. G. and Robbins, W. R.—Some Effects of Potassium Deficiency on the Histological Structure and Nitrogenous and Carbohydrate Constituents of Plants. *New Jersey Agric. Expt. Sta. Bull.*, 499, 1930.

(11) Maskell, E. J.—Field Observations on Starch Production in the Leaves of the Potato. *Ann. Bot.*, 1927, XLI, pp. 327-344.

(12) James, W. O.—Studies of the Physiological Importance of the Mineral Elements in Plants I. The Relation of Potassium to the Properties and Functions of the Leaf. *Ann. Bot.*, 1930, XLIV, pp. 173-198.

(13) Mann, C. E. T.—The Physiology of the Nutrition of Fruit Trees, I. *Univ. of Bristol Agric. and Hort. Res. Sta., Ann. Rept.*, 1924.

(14) Brenchley, W. E.—The Phosphate Requirement of Barley at different Periods of Growth. *Ann. Bot.*, 1929, XLIII, pp. 89-110.

(15) Knowles, F. and Watkins, J. E.—The Assimilation and Translocation of Plant Nutrients in Wheat During Growth. *Journ. Agric. Sci.*, 1931, XXI, pp. 612-637.

(16) Hardy, F., Akhurst, C. G. and Griffith, G.—Studies in West Indian Soils (III). Report on the Cacao Soils of Tobago. February, 1931, Trinidad, Imperial College of Tropical Agriculture.

(17) Hardy, F., McDonald, J. A., Rodriguez, G.—Studies in West Indian Soils (IV). Report on the Cacao Soils of Grenada. December, 1932, Trinidad, Imperial College of Tropical Agriculture.

(18) McDonald, J. A., Hardy, F. and Rodriguez, G.—Studies in West Indian Soils (VII). Report on the Cacao Soils of Trinidad, (A) Montserrat District. October, 1933, Trinidad, Imperial College of Tropical Agriculture.

(19) Reed, H. A. and Haas, A. R. C.—Studies on the Effects of Sodium, Potassium and Calcium on Young Orange Trees. *Univ. California Pub. Tech. Paper*, 1923, XI, pp. 1-33.

(20) Camargo, T. de.—Influence of the Potash : Nitrogen Ratio on the Development of the Coffee Tree during the First Period of Growth. *Compt. Rend.*, 1931, CXCIII, p. 1032 ; Abstr., *Proc. Intern. Soc. Soil Sci.*, 1932, VII, 1, p. 23 and *Tropical Agriculture*, 1932, IX, 9, p. 295.

(21) Russell, E. J.—Soil Conditions and Plant Growth, 6th Edit., 1932, London, pp. 60-115.

(22) McDonald, J. A.—Chemical Composition of the Leaves of Cacao in Relation to Environmental Growth Conditions, and with Special Reference to Thrips Attack. Second Annual Report on Cacao Research, 1932 (B) Chemical and Ecological Section, 1933, Trinidad, Imperial College of Tropical Agriculture.

(23) Kraus, E. J. and Kraybil, H. R.—Vegetation and Reproduction with Special Reference to the Tomato. *Oregon Agr. Expt. Sta. Bull.*, 149, 1918.

(24) Fischer, H.—Zur Frange der Kohlensaureernahrung der Pflanzen. *Gartenflora*, 1916, LXV, p. 232.

(25) Hooker, H. D.—A Survey of Investigations by American Horticulturists on Carbohydrate : Nitrogen Relation. *Journ. Pomol. and Hort. Sci.*, 1925, V, pp. 34-42.

(26) Cheesman, E. E.—Fruitfulness Physiological Factors affecting Yield in Tropical Crops. *Tropical Agriculture*, 1925, II, p. 60.

(27) Taylor, H. V.—Meteorological Research and Fruit Production.—Paper read before the Conference of Empire Meteorologists, Agricultural Section, 1929, London.

(28) McDonald, J. A.—A Sensitive Pot Test for Phosphate Deficiency in Soils. *Tropical Agriculture*, 1933, X, pp. 108-111.

THE WORLD COTTON POSITION.

By John A. Todd, M.A., B.L.

It is generally believed now that we have seen the worst of the great depression which began with the Wall Street crash in October, 1929, and although it may be to some extent a case of the wish being father to the thought the fact remains that cotton prices are now a great deal better than the worst. Thus on 10th August, 1931, Liverpool October futures (the nearest active month) touched 3.38d. while on 10th August of this year, by a curious coincidence, they rose to 7.23d. On 9th June, 1932, the current month futures in New York touched 4.85 cents, which was a new low record for all time, while on 9th August, 1934, October futures reached 13.84 cents.

These comparisons, however, cannot be taken quite at their face value. Thus the fact that the low point in Liverpool was in August, 1931, while in New York it was in June 1932, was entirely due to England's going off the gold standard in September, 1931; but for that Liverpool would also have touched a new low record in June, 1932. This also explains the apparently greater recovery in New York than in Liverpool, for if England had remained on the gold standard Liverpool would probably have fallen to about 2.50d. in June, 1932.

How far is this recovery due to depreciation of the currencies, both our own and American? Roughly speaking both now stand at about 60 per cent. of par as against the French franc, which is still on gold, so that the equivalent gold values of the recent high prices would be about 4¼d. and 8¼ cents in Liverpool and New York respectively.

The next question is how far this recovery has been justified by the changed conditions of supply and demand. In any attempt to correlate supplies and prices the effective supply which must be taken into account is of course the crop plus the carryover. Table I A gives the particulars of the American carryover at the beginning of each season and the crop, making the season's total supply, and against this there are shown the Federation's figures of consumption for the season and the season's average spot prices in Liverpool. All these figures are set out in Diagram I which brings out very clearly what has been happening in recent years. In 1929-30 the World's consumption was considerably reduced, largely in the second half of the season after the Wall Street crash, with the result that the season's total was less than the crop and nearly two million bales were added to the carryover. In 1930-31 this movement went still further so that although the crop was slightly smaller, the consumption was again far below the crop and a further substantial addition was made to the carryover. In 1931-32 the consumption made a fair recovery but owing to a bumper crop it was again very far below the production so that the carryover mounted to a new record figure of 12,798,000 bales, or more than a year's consumption. In 1932-33 the consumption made a further recovery and the crop was very sharply reduced, with the result that the carryover lost more than a million bales during that season. During the 1933-34 season, however, in spite of tremendous efforts to reduce the acreage, the crop figure (in running bales) showed very little reduction, while the consumption was considerably less than in the previous season, but it was still more than the crop, so that the carryover was again reduced to 10½ million bales.

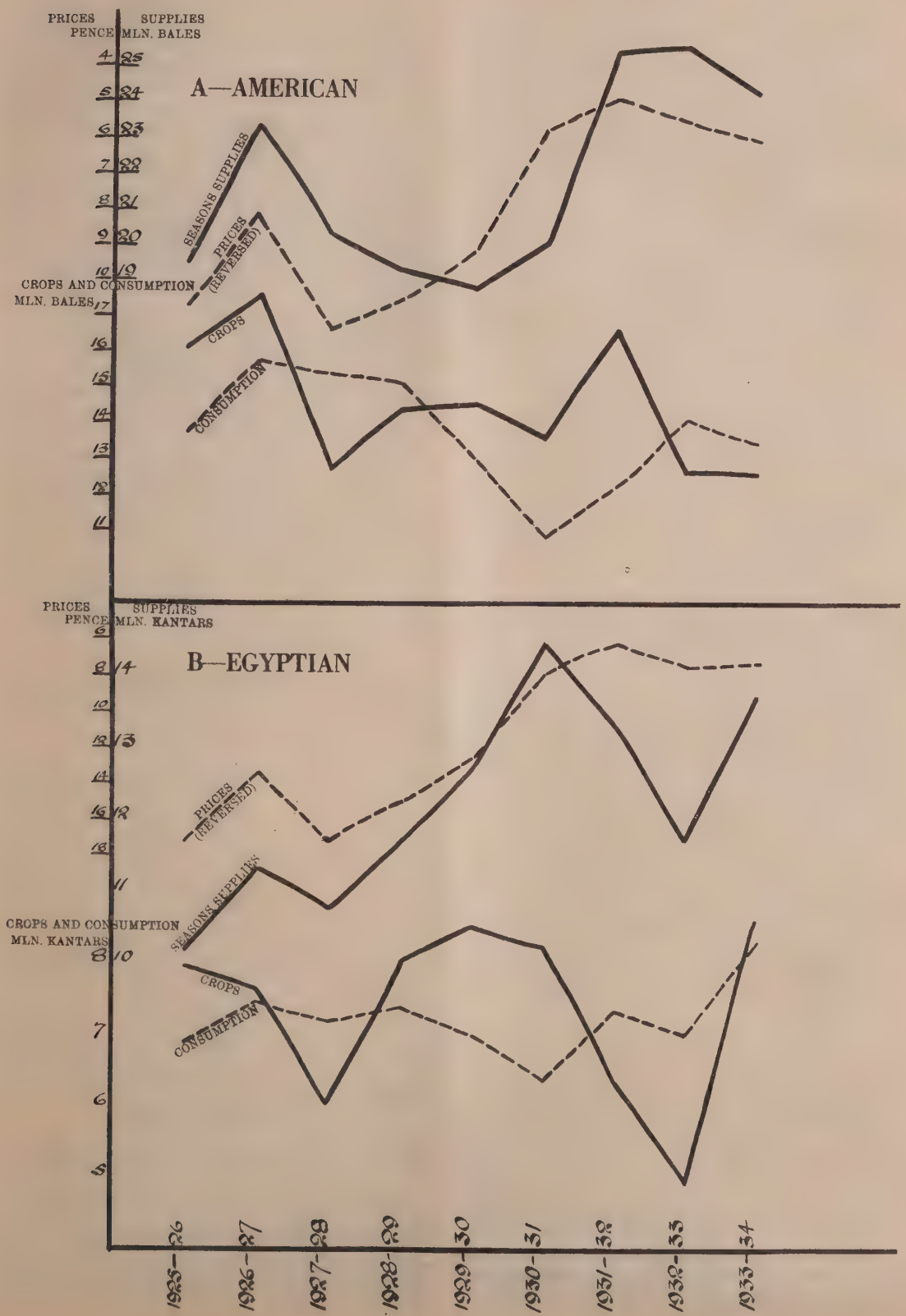
TABLE IA.—Supply, Consumption and Prices of American

Season.	Carryover at beginning of Season.	Crop.	Seasons' Supply.	World's Consumption (Federation)	Seasons' Average Spot prices in Liverpool.
	(Running bales 000's excluding linters).				Pence per lb.
1925-26	3.324	16.123	19.447	13.736	10.77
1926-27	5.358	17.755	23.113	15.777	8.15
1927-28	7.484	12.783	20.267	15.407	11.17
1928-29	4.952	14.297	19.249	15.066	10.52
1929-30	4.332	14.548	18.880	13.015	9.09
1930-31	6.249	13.756	20.005	10.901	5.71
1931-32	8.816	16.629	25.445	12.316	4.82
1932-33	12.798	12.710	25.508	14.171	5.48
1933-34	11.550	12.664	24.214	13.535	6.02
1934-35	10.510	**9.634**	**20.144**		

Estimates in heavy type.

Diagram I shows not only the curves of crop and consumption but also curves for total supplies and prices, and the correlation between these two is fairly close. Prices fell rather more than they should have done in the three seasons 1928-1930, but made a better recovery in 1931 than might have been expected, as the result of inflation, and then have since followed the course of supplies fairly well.

These crop conditions of course were far from being the result of leaving things to the free play of economic conditions. Ever since 1929 the American Government has been making desperate efforts to reduce acreage in order to restrict production, but the response of the planters in 1930 was very inadequate. In 1931 it was only a little better than an acreage reduction of about 10 per cent. which was much more than offset by the tremendous yield per acre. In 1932 again there was a further small reduction


PRICES PENCE
SUPPLIES MLN. BALES
A—AMERICAN
SEASONS SUPPLIES
PRICES (REVERSED)
CROPS AND CONSUMPTION MLN. BALES
CROPS
CONSUMPTION
PRICES PENCE
SUPPLIES MLN. KANTARS
B—EGYPTIAN
PRICES (REVERSED)
SEASONS SUPPLIES
CROPS AND CONSUMPTION MLN. KANTARS
CROPS
CONSUMPTION
1925–26
1926–27
1927–28
1928–29
1929–30
1930–31
1931–32
1932–33
1933–34

of acreage, but this time the average yield suffered a sharp reduction. In 1933 further elaborate plans were made for securing a substantial reduction of acreage by paying the planters not to grow cotton, but, owing to the delay in getting the legislation through Congress, the acreage planted was actually considerably more than in 1932 and the restriction plans had to be converted into a scheme for ploughing under cotton already planted. This resulted in a "special abandonment" of over 10 million acres or practically a quarter of the whole area, but by the irony of fate the average yield again proved embarrassingly bountiful and the crop (in 500 lb. bales) turned out to be actually a little more than the previous year.

Turning now to consumption it is important to observe how that was affected by the abnormal conditions of supply and prices. Normally the world's cotton consumption follows these conditions very quickly. As in 1926-27 for example, a big crop followed by a low price produced an immediate recovery in consumption, extending into the next two seasons, which quickly took off the excess of supply; but since 1929 events have been very different. This time the fall of prices was almost certainly the *result* of reduced consumption and in 1931-32 when a bumper crop produced record supplies the consumption only responded very slowly.

Here, however, we must extend our consideration beyond the conditions which affected the American crop alone, for these years have provided a remarkable illustration of the way in which consumption changes over from American to Outside Growths in accordance with changes in relative prices. Thus in 1929-30 when the world's consumption of American was falling off sharply, that of Outside Growths gained a large part of what American lost. In 1930-31 the reduced consumption affected all varieties but in 1931-32 owing to the huge American crop and, as it happened, a very small Indian crop, the world, especially the Orient, swung back to the consumption of American at the expense of Indian, while in 1932-33 the increase of consumption affected all countries, but American again gained the greatest advantage. In 1933-34 the position was reversed and Outside Growths gained heavily at the expense of American. (*See* Table II.)

In the case of Egyptian, which in view of its high quality and value is the most important crop next to American, the position in the last few years has been very different. In 1930 the acreage increased a little to a new record, but as the average yield was comparatively poor the crop was smaller than in the previous year. In 1931 the authorities inaugurated a drastic reduction of acreage and as the average yield was again rather low the crop was substantially reduced. In 1932 the reduction of acreage was carried so far that the total was little more than half of that planted in 1930, but that year the average yield made a very good recovery so that the reduction of the crop was not in proportion to the acreage. In 1933, the Government having by this time practically disposed of the whole of the accumulated purchases which they had made in previous years, the acreage restrictions were relaxed, and as the average yield was again very good the result was a new record crop, though not by much for the final yield was less than the early estimates.

In the meantime the Egyptian Government had made strenuous efforts to increase the consumption of Egyptian, especially of Uppers in countries on the Continent and elsewhere which had formerly used nothing above American, and owing to the comparatively low price of Egyptian these efforts were crowned with considerable success. Thus the consumption which had fallen a little in 1929-30 fell still further in 1930-31 with the result that the carryover at the end of that season established a new record. In 1931-32, in spite of the big American crop of that year, consumption made a very good recovery, and although this high level was not maintained in 1932-33 it was substantially exceeded in 1933-34 which established a new record. Owing to the very large crop of 1933, however, the consumption hardly reached the total production so that the carryover which had been substantially reduced in the two previous years should have been slightly increased again. Actually however the computed carryover showed a small decrease. All these figures for Egyptian are given in Table IB.

TABLE IB.—Egyptian.

Season.	Carry-over.	Crop.	Seasons' Supply.	Con-sump-tion.	Prices.*
	Kantars (of 100 lbs.) 000's.				
1925-26	2.222	7.965	10.187	6.900	17.23
1926-27	3.658	7.652	11.310	7.450	13.49
1927-28	4.712	6.087	10.799	7.200	17.01
1928-29	3.573	8.068	11.641	7.400	15.13
1929-30	4.243	8.531	12.774	7.028	12.49
1930-31	6.131	8.276	14.407	6.398	7.96
1931-32	6.959	6.357	13.316	7.350	6.24
1932-33	6.762	4.956	11.718	7.020	7.40
1933-34	5.081	8.575	13.656	8.310	**7.31**
1934-35	5.048	**8.217**	**13.265**	...	....

Estimates in heavy type.

* Mean of Sakel and Uppers. Spot Prices in Liverpool.

As to all the other crops which go to make up the total of Outside Growths (with Indian and Egyptian) there is only room to say that the total of these showed a little reduction from the

record of 1928 until 1931 when, largely as the result of the small Indian crop, the total was the smallest since 1923. 1932 showed only a small recovery in Indian while the total of the rest of the Outside Growths was practically unchanged; but in 1933 with the Indian crop still showing a comparatively small figure almost every one of the other crops showed a substantial increase, with the result that the world's total of Outside Growths was well above the previous record figure of 1928. Thus the total production of Outside Growths in 1933-34 was more than the American crop (excluding linters), a thing which has never happened before except in the three disastrous weevil years of 1921-23 when the American crop was almost decimated.

Table II summarises the whole world position of crops and consumption distinguishing between American and Outside Growths, but it is impossible to get anything like reliable statistics of the carryover of all the Outside Growths to complete the table in the same fashion as the American and Egyptian tables already given.

TABLE II.—World's Crop and Consumption. American *vs.* Outside Growths.

	World's Crop.			Consumption.		
	American.	Outside Growths.	Total.	American.	Outside Growths.	Total.
1925-26	16.104	12.585	28.689	13.736	10.950	24.686
1926-27	17.977	11.018	28.995	15.777	10.362	26.139
1927-28	12.956	11.745	24.701	15.407	10.134	25.541
1928-29	14.478	13.069	27.547	15.066	10.806	25.872
1929-30	14.825	12.401	27.226	13.015	12.186	25.201
1930-31	13.932	12.684	26.616	10.901	11.580	22.481
1931-32	17.096	10.914	28.010	12.316	10.003	22.319
1932-33	13.002	11.454	24.456	14.171	10.182	24.353
1933-34	13.047	13.811	26.858	13.535	11.577	25.112
1934-35	**9.634**	**14.000**	**23.634**			

Estimates in heavy type.

Note.—The crop figures are in 500 lb. bales and the consumption figures in running bales, which vary from 400 lb. to 750 lb. This does not make much difference in American (*cf.* Table Ia) but does in the case of Outside Growths. On the other hand the consumption figures are for the World's *Mill* consumption only excluding domestic consumption. Direct comparisons of production and consumption must therefore be made with reservation but year to year comparisons are not seriously affected.

Is it possible to draw from all this any general conclusion as to the whole position? Perhaps this much may be risked. Production, consumption and prices have all made a pretty good recovery from the low points of a year or two ago, but the critical feature of the whole situation is that the recovery during 1933-34, both in production and consumption, was much more marked in the case of Outside Growths than of American, because America's efforts to restrict production were only then beginning to show results.

In another article it will be shown how the position has developed during the early part of the new season, 1934-35. The effect of the world position on the Empire cotton crops and especially on the West Indian Sea Island position will also be dealt with.

THE 1934 DATE CROP.

The opening prices of the season for the three main commercial varieties of dates were fixed recently at a meeting of the chief growers and exporters as follows:—

	£	s.	d.	
Hallawi	8	3	8	a ton.
Khadrawi	6	0	0	,,
Sayir (*i.e.*, Usta 'Imran)	4	18	2	,,

Owing to the prevailing economic depression but especially to its effect in America, there is a much greater demand for the cheapest variety which is almost certain to maintain its price, and probably will rise, while the Hallawi is likely to fall, as soon as the first American shipments have been made. In view of the increased demand for Sayir in impoverished Europe and America, and the consequent restriction in the quantity of this variety which will be available for the Persian Gulf, India and East Africa, the prices of Dayri and Zahdi and inferior Hallawi, all of which are likely to be used to fill the gap, will probably remain firm or stiffen.

No official forecast of the size of the crop is made; but the export from Basrah of this season's crop may be anticipated as follows:—

Hallawi	33,000	tons
Khadrawi	6,000	,,
Sayir	50,000	,,
Other varieties ..	41,000	,,
Total	130,000	,,

Adverse weather conditions have resulted in the drying out of a large part of the Hallawi crop, of which probably as much as a quarter is too dry for packing in boxes for the European and American trade, and will have to be packed in baskets for eastern markets. The price of the good quality Hallawi has accordingly opened very high compared with that of Sayir.

The quality of both Khadrawi and Sayir is good.

V. H. W. Dowson.

WEST INDIAN NOTES.

(Compiled by the Advisory Department, Imperial College of Tropical Agriculture.)

The Sugar Industry.

Unfavourable climatic conditions have affected the sugar crops in most of the islands, short crops being expected during 1935 in Antigua, Barbados and Trinidad. Whilst 'good' rains have been experienced in Trinidad during October and November, in Barbados and Antigua the rainfall has been very deficient. In St. Kitts the position of the crop is not as satisfactory as it was at the same period in 1934, but a fair crop may be anticipated. In St. Lucia the crop is generally satisfactory on most of the sugar estates.

New varieties of sugar-cane have been received at the Plant Quarantine Station from Washington and from Barbados, a number of which will be available in due course for distribution to the Agricultural Departments in the islands.

It is hoped to conclude arrangements for the introduction into Montserrat of *Lixophaga*, the Cuba fly, which is parasitic on the larva of the small moth borer and which has been successfully introduced by Mr. H. E. Box into Antigua, St. Kitts and parts of St. Lucia. An effort is also being made to introduce into St. Lucia the Amazon fly, a parasite recently introduced by Dr. Myers into British Guiana.

Proposals have recently been submitted for carrying on the work of the Central Cane Breeding Station in Barbados after 1935.

* * *

Sea Island Cotton Industry.

The Sea Island cotton crop for 1934 is now practically reaped, production for the year amounting to 830,000 lb. The stocks on hand of Sea Island cotton have been reduced from 2,733,000 lb. in 1932 to 720,000 lb. in October, 1934. The annual general meeting of the West Indian Sea Island Cotton Association was held in Montserrat in November, 1934, when delegates from most of the cotton growing islands attended. Important matters dealing with the industry were discussed. The Advisory Committee in England of the Association have met at frequent intervals during the past nine months, and Mr. Twyman, a member, gave an outline of the work of the Committee to the members of the Association. Suggestions for the more effective control of pink bollworm were discussed by the Association which also considered certain changes to the cotton seed control ordinance. The enforcement of this ordinance has contributed largely to the improvement in quality of the cotton produced in the Islands.

* * *

The Lime Industry.

It will be seen from the table that the total exports of lime products for 1933 from Trinidad, Montserrat, Dominica and St. Lucia were equivalent to 150,000 barrels of limes valued at £69,846. In 1922-23 Dominica alone exported 400,000 barrels. At an average yield of 100 barrels

EXPORTS OF LIME PRODUCTS DURING 1933.

Islands	Distilled Lime Oil (lb.)			Hand-Pressed or Ecuelled Lime Oil (lb.).			Green Limes (barrels).		Raw Lime Juice. (gallons).			Concentrated Lime Juice (gals.).		Citrate of Lime (lb.)		Total Value.		
	Quant.	£	(brls.)	Quant.	£	(brls.)	Quant.	£	Quant.	£	(brls.).	Quant.	£	Quant.	£	Crop (brls.)	£	(Price per brl.)
																		s. d.
Trinidad	15,851	21,415	45,804	583	1,160	4,661	2,101	2,381 16	17,375	1,203	2,316	11,700	622	52,800	380	54,885	27,170	9 11
Dominica	9,302	10,695	26,946	320	353	2,560	3,130	4,893	37,770	1,889	5,037	35,467	1,817	....	....	39,673	19,663	9 11
St. Lucia	7,582	7,412	15,456	2,430	3,021	19,440	3,758	4,445	591	40	79	10,208	800	...	...	38,733	15,778	8 2
Montserrat	...	....	....	1,113	1,680	8,904	2,052	1,324	48,691	4,231	6,492	....	....	....	....	17,448	7,235	8 3
Total ...	32,735	39,522	88,206	4,446	6,214	35,565	11,041	13,050	104,427	7,363	13,924	93,384	3,260	52,800	380	150,739	69,846	9 3

of limes per acre the whole of the 1933 crop could have been produced from 1,500 acres of fully grown limes. It is estimated that more than 6,000 acres of limes have been planted during the past ten years in these islands, the potential yield of which will approximate 600,000 barrels. The Gold Coast, in addition, is estimated to have about 2,000 acres under limes. These figures indicate that there is likely to be a large increase in the production of limes. In view of the fact that the lime industry has lost its market for citric acid and to a certain extent for raw juice and that it is now mainly dependent on the demand for essential oil and fresh fruit it would appear that further extensions of lime cultivation at present are undesirable.

Arrangements have been completed for the introduction of a parasite on the citrus mealy bug which is an insect pest of Montserrat. The parasite is a lady bird and is being introduced in co-operation with the Farnham House Laboratory.

* * *

Tomatoes.

In a progress report from Montserrat the Curator records a more satisfactory season for tomatoes especially as regards prices although the volume of production was considerably smaller than in previous years. It is pointed out that tomatoes exported during April and May usually command better prices than those shipped earlier in the year. The "Globe" variety has completely displaced "Bonny Best."

* * *

Bananas.

The exports of bananas from the Islands for the periods January to October, 1933 and 1934 are as follows :—

Island.	1933 *Jan.-Oct.* (*bunches.*)	1934 *Jan.-Oct.* (*bunches.*)
Dominica	13,353	26,863
St. Lucia	18,170	15,031
Trinidad	417	40,509
Total....	31,940	82,403

The areas under this crop have been extended considerably and a substantial increase in exports is anticipated during 1935, especially from Grenada where large areas have been planted during the past 12 months.

MISCELLANEOUS NEWS.

Mr. G. A. Jones, Commissioner of Agriculture, returned to Trinidad from leave on 15th October.

* * *

Mr. V. G. Pereira, Agricultural Assistant, Antigua, arrived in Trinidad on 1st October to take a refresher course at the College.

* * *

Mr. H. B. Pidduck, Acting Agricultural Superintendent, Dominica, returned to his duties as Northern District Agricultural Officer on 31st October.

* * *

Visits to Antigua, Montserrat and St. Kitts were made by the Commissioner of Agriculture, and the Assistant Commissioner of Agriculture during November and December.

* * *

Mr. T. A. Twyman, Managing Director of the Montserrat Company, Birmingham, England, and a member of the Advisory Committee of the West Indian Sea Island Cotton Association spent a week in Trinidad *en route* for Montserrat.

* * *

Mr. H. E. Box, Entomologist attached to the College Agricultural Advisory Department paid a visit to Trinidad from 10th to 18th October, when a programme of work was arranged in consultation with the Commissioner of Agriculture and Dr. J. G. Myers.

* * *

Dr. J. G. Myers, Entomologist, paid visits to Antigua and St. Kitts, during November and December to survey the position with regard to moth borer control in those islands. Dr. Myers also visited Grenada and St. Vincent, returning on 12th November.

Mr. C. C. Skeete, B.A. (Cantab.), Assistant Director of Agriculture, Barbados, has been appointed with the approval of the Secretary of State for the Colonies as Assistant Commissioner of Agriculture to the Agricultural Advisory Department at the College.

* * *

Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture, visited Antigua and St. Kitts, during November and December in connection with experiments laid down by the Agricultural Department in co-operation with the Sugar Cane Investigation Committees of those islands.

* * *

The annual general meeting of the West Indian Sea Island Cotton Association was held in Montserrat from 28th November to 4th December. It was attended by the President of the Association, delegates from St. Vincent, Barbados and St. Kitts and by Mr. T. A. Twyman, a member of the Advisory Committee. A meeting of the Executive Committee of the Association was also held in Montserrat on 27th November.

* * *

The following officers recently returned from leave :—Mr. F. G. Harcourt, M.B.E., Agricultural Superintendent, Dominica (26th October), Mr. S. H. Evelyn, Cotton Research Officer, St. Vincent (18th August), who attended the Cotton Conference convened by the Empire Cotton Growing Corporation and Mr. P. E. Turner, Adviser in Sugar Cane Experiments to the Commissioner of Agriculture (1st October).

PACKING BERMUDA TOMATOES.

By E. A. McCallan.

It was recommended at the Jamaica Agricultural Conference held in October, 1933 that "Tomatoes should be packed . . . in the British Columbia 20-lb. lug with the following outside measurements $15\frac{3}{4} \times 15\frac{3}{4} \times 4\frac{1}{2}$ inches, . . . the following sizes should be recognised :—

50's—5 x 5 of uniform size 2 tiers deep wrapped
72's—6 x 6 of uniform size 2 tiers deep wrapped
98's—7 x 7 of uniform size 2 tiers deep wrapped
144's—8 x 9 of uniform size 2 tiers deep wrapped
Jumble pack not less than $1\frac{1}{2}$ inches in diameter."

The Mexican 30-lb. lug was recommended also.

The British Columbia lug has been in use in Bermuda since 1931, and has been modified in several minor respects before it assumed its present form.

The illustration accompanying this article shows tomatoes packed in Bermuda in the 20-lb. lug. The fruit so packed is mechanically sized by being run over a Cutler tomato grader, a description of which has already appeared in these columns.* The balance scales of the grader are easily and quickly adjusted, so that it is not a difficult task to maintain a tight pack, uniform weight and accurate count. Sizes 50's, 72's and 98's are packed on the flat, and 144's are packed on the edge with longest axis at right angles to the bottom of the lug.

Jumble pack is marked "small" in the photograph.

In the 1933 season the various sizes named above formed the following respective percentages of the total quantity of Government-packed tomatoes exported :—

Size.	*Number of lugs.*	*Percentage of whole.*
50's	224	.71
72's	5,371	17.35
98's	16,036	51.81
144's	7,952	25.69
Jumble pack	1,373	4.44
	30,956 lugs	

In addition to the above 10,601 lugs of farm-packed tomatoes were exported; a total of 41,557 lugs. In the 1934 season a total of 51,135 lugs were exported, of which 48,236 lugs, or 94 per cent. were packed by the Department of Agriculture.

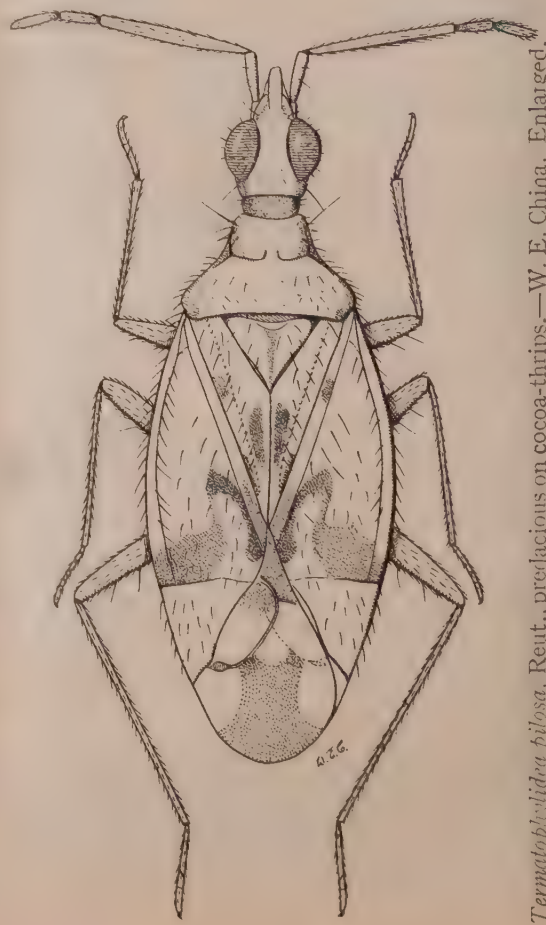
* *Tropical Agriculture*, Vol. IX, No. 3.

NOTES ON COCOA-BEETLE AND COCOA-THRIPS.

By J. G. Myers.

1. A New Host-plant of the Cocoa-beetle (*Stirastoma depressum*).—The two most important wild host-plants of the cocoa-beetle hitherto noted in Trinidad are the tree known as wild chataigne (*Pachira insignis*) and a semi-woody, yellow-flowered waste-land and roadside weed (*Malachra alceifolia*). Other, but less frequent plant-hosts recorded in Trinidad by Carr, by Urich and by Guppy are the forest mahoe (*Sterculia caribaea*), cannonball tree (*Couroupita guianensis*) and okra (*Hibiscus esculentus*). To these must now be added a sixth which is probably of almost equal importance with wild chataigne and *Malachra*, at least in the coastal regions. This is the common seaside mahoe (*Hibiscus tiliaceus*) which has been found heavily infested by cocoa-beetle, on the seaward border of the Nariva swamp, between the swamp and the Cocal.

2. A Useful Predator on Cocoa-thrips (*Heliothrips rubrocinctus*) in Jamaica. — As long ago as 1929, the nymphs of a small Capsid bug were found preying on cocoa-thrips at a restricted locality in Jamaica, on the edge of the John Crow Mountains. No adults were found, and none was successfully reared owing to exigencies of travelling. On a later visit more material was collected from the same trees, and adults were obtained. Mr. W. E. China, of the British Museum (Natural History) to whom I am deeply indebted for the excellent drawing of the insect, identified it as an aberrant Mirid (Capsid) bug, *Termatophylidea pilosa*, Reut., discovered by Van Duzee in Jamaica some thirty years ago, and not recorded since.



Termatophylidea pilosa, Reut., predacious on cocoa-thrips.—W. E. China. Enlarged.

THE PACKING OF TOMATOES IN BERMUDA.

Showing method of Packing Tomatoes in a 20 lb. lug.

(A) (B)

Typical 'Marsh' Seedless Grapefruit on Sour Orange Stock, (A, before pruning) (B, after pruning). Height including roots, 5 feet. The lower mark indicates the bud union at 17 inches from soil level, the median mark indicates pruning point for the branch system, the upper marks indicate the points for heading back prior to distribution.

PRODUCTION OF BUDDED CITRUS PLANTS IN ST. LUCIA.

By A. F. Nichols, A.I.C.T.A.

The two main nurseries of the St. Lucia Agricultural Department are situated in the planting areas at the Union Experiment Station, and at Rabot Estate in the Soufrière District. The soil in the Union nurseries is suitable for the cultivation of sugar-cane, and consists of river alluvium which would be classed as a clayey loam, whilst that of the Rabot nursery is a very loose and sandy volcanic soil situated on a hillside in a cacao environment.

Selection of Seeds.

Seeds are selected for size and shape from healthy fruits off good bearing sour orange trees. In practice, 40 to 60 per cent. of the seeds have to be discarded because they are of thin shape and poor size. The trouble and cost of rigid selection of seed are amply repaid by improved germination and the production of a uniform stand of vigorous seedlings.

Method of Sowing.

Beds of any convenient length four feet wide with two-foot drains between them are made, the drains also serving as paths. Furrows half an inch deep and six inches apart are made at right angles to the length of the bed, and in these the seeds are sown, between the months of January and March, about two inches apart, covered with half an inch of soil, and pressed firmly. The width of the beds should not exceed four and a half feet or it will become necessary for labourers to step on the beds when weeding and pruning. Deep tillage of the beds is essential as adequate root room for the seedlings must be provided to avoid the formation of twisted or "bench" roots.

Transplanting.

In St. Lucia transplanting is carried out only once during the months of June and July, a period which coincides with the beginning of the rainy season. The seedlings by that time are from five to seven months old and about ten inches high. Cool or rainy days should be selected for transplanting as in order to reduce excessive transpiration it will then be necessary to remove only a small proportion of the leaves to prevent wilting. An additional advantage is that if the soil is wet the seedlings can be lifted with a minimum of damage to the root system.

Either because of "bench" roots or general weakness and slowness of growth about 20 per cent. of the seedlings in the seed beds have to be discarded. The seedlings are lifted carefully and each tap root is trimmed with a sharp knife to a length of about eight inches to encourage the rapid production of a callus and subsequent root formation and to reduce the chances of root rot. The seedlings are planted about 18 inches apart in budding beds four feet wide. The holes are dug with a pointed stick or dibble and should be deep enough to take the whole length of the tap roots of the seedlings. Great care is taken to protect the roots from the sun, and when set out the soil is pressed firmly round them. The work of transplanting seedlings is most important and is only performed by trustworthy nurserymen.

Manuring and Mulching.

Three or four weeks after transplanting the stocks from the seed beds, a small application of about half a teaspoonful of Sulphate of Ammonia is given to each plant. Subsequently two or three similar applications may be given during the time the stocks are in the budding beds. The latter are always heavily mulched with trash or dried grass at the end of the rainy season and if a dry spell is experienced soon after transplanting the stocks, mulching is also practised.

Selection of Budwood.

The careful selection of budwood is essential for two reasons—firstly, the success of budding in the nursery—and secondly, the proper development of well-balanced and productive trees. Hence budwood should be taken from mature trees producing a large number of marketable fruits. It has been found that a slightly angular budwood gives the best results in budding.

Method of Budding.

Under normal weather conditions, budding starts early in January and finishes in May, corresponding roughly with the dry season. The stocks are budded at 18 inches from the ground to reduce the risk of attack by gumming diseases on susceptible scions. Budding is usually done when the stocks are about one quarter of an inch in diameter and the green bark is beginning to show greyish streaks. It is performed between the ages of 11 and 14 months and the inverted T method (⊥) is practised exclusively. A very sharp knife must be used in the cutting of the buds and a thin layer of wood removed along with the bark. The strip of bark which is to be inserted in each incision of the stocks should be about one inch long. The bud-strip is pushed upwards into the incision and is firmly bound in place with raffia, great care being taken to leave the actual bud exposed.

At the time of budding, the top of the stock is either completely removed about six inches above the bud, or is half cut through and bent over to protect the bud from the direct rays of the sun during dry weather. Ten days after budding, the buds are inspected and if they are still green it is likely that the operation has been successful. The buds begin to grow about three weeks after budding and as soon as the shoots are about two inches long they are each carefully tied to

that portion of the stock remaining above the bud. When the shoot is about ten inches long and is sufficiently strong to be tied to a stake, the projecting portion of the stock is removed with a sharp knife. The pruning cut is made in a slanting direction as close to the bud as possible.

As soon as the upper portion of the stock is removed an upright stake is pushed firmly into the ground about two inches from the base of the stock and on the side opposite to the bud. The shoot is then carefully tied to the stake with any available material except twine as this is likely to cut through the shoot. The original tying of the shoots to the upper portions of the stocks and the final tying of the stakes are both essential for the production of plants with straight stems.

All young shoots up to a height of 30 inches, whether arising from the stock or scion, are rubbed off by hand.

Formation of the Scaffold or Lateral Branches.

To obtain a well-shaped citrus plant a minimum of three, and a maximum of seven, lateral branches should be produced radially between 28 and 35 inches from the ground. The lateral branches should be spaced as widely as possible, or otherwise excessive strain localised in a small area is likely to lead to branch fracture and subsequent mal formation of the tree.

If the mode of growth of young orange and grapefruit plants be closely followed, it will be found that flushes arise from the apices of mature shoots, which if unchecked, produce a number of secondary branches originating from one point. As already stated, this arrangement is undesirable.

The best method of producing well-spaced scaffold branches, is to allow the buds at the apex of the stem to grow until branches about one foot long are produced. The stem is then cut back into the older wood just below these young shoots. This procedure ensures that the buds below the cut are sufficiently mature, so that at least three buds will begin to grow about one week after topping.

Distribution of Plants.

When the scaffold branches become mature and themselves produce a flush (Fig. 1), they are cut back below this flush (Fig. 2), and the plant will be ready for distribution from the nursery about five days after cutting back. The interval of five days, between the cutting back of the scaffold branches and the lifting of the plants, is allowed to stimulate the growth of buds and so encourage rapid growth after transplanting. Plants budded late in the year, and others too small to distribute in December, are carried over for early distribution in the next planting season. The scaffold branches of these plants usually produce about three flushes during the dry season, hence they have a large spread when the weather becomes wet enough to transplant in the following rainy season. Before lifting, however, they are cut back as in Fig. 2.

Removal of Plants from the Nursery.

All the plants distributed from the nurseries of the Agricultural Department are lifted with a ball of earth about 12 inches long and five inches wide. Each ball is wrapped separately in banana trash or other suitable material.

Control of Diseases and Pests.

Citrus scab (*Sphaceloma fawcettii*, Jenkins.), has never attacked the sour orange stocks in the Rabot nursery. On the other hand, stocks at Union are seriously affected during the rainy season if they are less than one foot high. Some control of scab has been effected by spraying with Bordeaux Mixture, and artificial shading with coconut leaves, but neither method has proved very successful. It has been found that scab does not prevent the formation of a single straight stem suitable for budding, if the disease does not attack the stocks before they have reached a height of 15 to 18 inches. The difficulties experienced in controlling scab at Union have thus been completely eliminated by growing all the sour orange seedlings in the Rabot nursery and transplanting them to the budding beds at Union when they are 15 to 18 inches tall.

The purple scale (*Lepidosapes beckii*, Newm.), the green scale (*Coccus viridis*) and mites (*Tetranychus spp.*), give a certain amount of trouble in the nurseries but they are all kept under control by spraying with three per cent. sulphemulsol or resin wash.

Summary of Operations performed in the Nursery with Corresponding Ages of the Plants.

Operation.	*Time of Operation.*	*Age of Plant.*
Sowing of sour orange seeds	....Jan.-March	—
Seedlings transplanted	....June-July	4-6 months old.
Stocks budded	....Jan.-May (following year)	11-14 do.
Plants distributed	June-Novr.	18-22 do.

Cost of Producing Budded Citrus Plants.

Each plant in the Rabot nursery costs about seven pence, exclusive of the salaries of supervising agricultural officers, up to the time it is lifted from the nursery beds.

Acknowledgments.

The writer wishes to record his appreciation of the assistance rendered by Mr. E. A. Walters, the Agricultural Superintendent, and Mr. A. C. Shill, the Marketing Officer, in the compiling of this article.

AGRICULTURAL NOTE BOOK.

Copies of Professor Wood's "Note-Book of Tropical Agriculture" (price 5 shillings) may be obtained on application to the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

APPENDIX.

Standard Certificate.

(Strike out the words not applicable.)

This is to certify that (the living plants or plant products / a representative sample of the living plants or plant products) included in the consignment, of which particulars are given below was / were thoroughly examined on the (date).....

by (name).....a duly authorized official of the.....and found to be healthy, no evidence of the presence of any injurious insect, pest or disease [destructive to vegetation / destructive to agricultural or horticultural crops] having been found in/on them and that the consignment (including the packing) covered by this certificate has / has not been treated in the following manner (*e.g.* fumigated with.....or disinfected.....) prior / immediately subsequent to inspection.

Insert words in [ ] if required by existing legislation.

(Inspected / Not inspected) in the field by a duly authorized inspector, on.....

(Signature) .....

Date..... (Official Status) .....

No. and description of packages.....

Distinguishing marks.....

Description of living plants or plant products or parts thereof .....

Stated to be grown at.....

Exported by.....

Name and Address of consignee.....

Name or vessel or particulars of route.....

Date of shipment.....

Port or Place of entry .....

Supplementary Clause.

In the case of material consigned to this Plant Quarantine Station *each and all* of the living plants or plant products should be subjected to examination and treatment in accordance with the particulars given in the Standard Certificate.

REGULATIONS OF THE PLANT QUARANTINE STATION, TRINIDAD, B.W.I.

Introductory.

The countries to be served by the Quarantine Station are restricted to the British West Indies and other British Colonies in the Caribbean area.

2. The regulations shall apply to all imported planting material irrespective of the fact that it may have been received direct from another quarantine station.

3. All communications are to be addressed to the Secretary, The Plant Quarantine Station, Trinidad, B.W.I.

Conditions under which Plants or Planting Material will be accepted.

4. Material for treatment cannot be accepted from private persons and all requests for service must come from the Department of Agriculture of the importing country. In the case of the Windward and Leeward Islands the proper authority shall be the Commissioner of Agriculture.

5. A Colony wishing to import plants or planting material from another country shall apply to the Quarantine Committee who will take the necessary steps.

6. Applications must make clear :

(1) The material that it is desired to pass through the Quarantine Station.
(2) The quantity required.
(3) The country from which it is desired to import : and
(4) The name and address of the Department of Agriculture or other source with which the order is to be placed.

7. All plant material sent to the Quarantine Station without prior sanction shall be unconditionally destroyed by the officer in charge.

8. Requests that planting material be obtained from any specified part of the world shall be considered on their own merits and, particularly in the case of those countries where plant pathological services do not exist or are considered to be inadequate, The Plant Quarantine Committee shall in such instances have power to refuse.

9. Only small amounts of planting material of any variety of plant will be accepted in order to allow of thorough examination both prior to shipment and on arrival at the Quarantine Station. The actual amount shall be decided upon in each case by the Committee of the Plant Quarantine Station.

10. Each consignment must be accompanied by a certificate signed by a competent plant pathologist (Mycologist and/or Entomologist). The form of the certificate is given in the Appendix.

Editor's Note. A copy of the form of the Certificate (*i.e.* Appendix) which has been printed separately is inserted facing page 25.

11. Packages are to be strongly constructed and securely fastened and are to bear a special label clearly marked " Plant Quarantine Station, Imperial College of Tropical Agriculture, Trinidad, B.W.I. " which will be supplied by the Committee.

Procedure on Receipt of Plant Material.

12. All parcels containing the plant material shall be first opened inside the inspection chamber of the Plant Quarantine Station in the presence of the Heads of the Departments of Entomology and Mycology, Imperial College of Tropical Agriculture, Trinidad, or, in their absence, other qualified officers nominated by the Committee.

13. The imported plant material shall be subjected to special examination by both executive officers, any one of whom shall have full power to fumigate, disinfect or destroy forthwith the whole or part of the consignment. For this purpose the inspection chamber is equipped with (*i*) Vacuum Fumigator (*ii*) Hot air steriliser (*iii*) Autoclave, and (*iv*) Disinfecting fluids.

Subsequent Operations in Greenhouse.

14. The manner of dealing with the plant material subsequent to the preliminary examination in the inspection chamber shall be left to the discretion of the two executive officers in charge of the Plant Quarantine Station. The usual procedure will, however, be as follows :—

The planting material, after disinfection and thorough examination, will be taken into the inner greenhouse, No. 1. Series B. Moreover, when there is suspected risk of introducing a dangerous pest or disease on a specific plant from some particular region the quarantine period within the greenhouses shall be confined to Series B because of the added protection afforded throughout by the flanking series A and C.

15. In the case of Sugar Cane the quarantine period in the greenhouses shall extend over three generations, the third being grown to maturity. Similar precautions shall be taken with such tree crops as Citrus (by budding or other means) if there is the slightest likelihood of introducing a serious disease, *e.g.*, Canker.

16. Full power is given to the Executive Officers to destroy some or all of the propagated material at any time if they think it desirable on the grounds of specific diagnosis, or consider it necessary as a precautionary measure because of inexplicable abnormal symptoms.

17. Quarantined material required by colonies other than Trinidad shall not be allowed to be planted out-of-doors in Trinidad. In this manner the danger of introducing disease from Trinidad into other West Indian Colonies will be eliminated.

18. Material to be imported into Trinidad will, if necessary, be bulked up on the adjoining ground after release from the quarantine greenhouses.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Velocity of Crystallization of Sucrose.—*K. I. Smolenski and A. Zelezny.*

The authors have evolved a new method for determining the velocity of crystallization of sucrose, which consists in the addition of a certain amount of fine crystals to a supersaturated solution and a direct determination of the concentration of the mother-liquor by means of the refractometer, without removing the sugar crystals. The velocity of crystallization may be calculated by the formula : $V = S. \frac{N^2t}{No}$ where V is the speed of crystallization, S the crystal surface, N^2t the saturation number at a given moment, and No the original saturation number.

By means of this method the speeds of crystallization of sucrose in pure solutions at 25°C. and in solutions of purities of 95 and 80 were determined. Some of the results are shown in the accompanying table, which gives the time in minutes required to throw out 75 per cent. of the crystallizable sugar.

Saturation number.	Purities.		
	100	95	80
1.10	1.0	4.8	22.2
1.20	1.0	2.8	12.6
1.30	1.0	2.0	8.9
1.40	1.0	1.5	7.4
1.45	1.0	1.4	7.0
1.50	1.0	1.3	6.6

This table clearly shows the large depressing effect on the velocity of the crystallization of sucrose caused by lowering the purity.—(*Int. Sugar Jr.* Vol. XXXVI, No. 431, pp. 448, 1934.)

* * *

A Study of Millable Sugar Cane and Sucrose Formation.—*U. K. Das.*

This is an elaborate study of growth phenomena of the cane, divided into 19 chapters, with a summary, tables of data and illustrations. It is found that at any given time a cane crop consists of stalks of different ages, size, vigour and maturity, and the yield is naturally a composite which is influenced by the relative proportions of different stalk categories. Suckering is found to be a continuous process and is primarily induced by self-shading. The number of suckers reaches a maximum between four and five months of age, or just when the crop closes in. The number of suckers then declines to a more or less stable number of about three stalks per foot of row (H 109).

Under experimental conditions a crop of H 109 will consist of 80 to 100 per cent. of stalks that have germinated within three months after planting. Excellent juices have been obtained from both first and second season cane in spite of a continuous application of four inches of irrigation water per week to the very day of harvest. It is very definitely brought out that from the standpoint of quality millable cane may be classified as dry-leaf cane and green-leaf cane (that portion of the stalk to which green leaves still adhere).

The dry-leaf cane is generally mature, and the quality of the stalk will depend on the relative proportions of these two sections; maturation is a process of shortening the green-leaf section. Numerous other important points are taken up, including the new Hawaiian concept of "day degree" by which the correlation of cane growth to daily maximum temperatures is brought out. It is also suggested that perhaps the practice of abstaining from nitrogen fertilization in the second season may be a mistaken policy; late application of nitrogen fertilizer may lower the quality of the cane, but the chances are that a greater tonnage will give a larger yield of sugar.—(*Int. Sugar Jr.* Vol. XXXVI, No. 431, pp. 445-6, 1934.)

* * *

Manufacturing Qualities of POJ 2878.—*H. F. Hadfield.*

At the request of the H.S.P.A. Experiment Station, an investigation was made of the clarifying qualities of POJ 2878 cane in comparison with Yellow Caledonia and POJ 36. At the factory where the test was made Yellow Caledonia and other canes would clarify in about 45 minutes, with a turbidity reading of 3.5 to 4.0 cm. When POJ 2878 was crushed alone and limed to pH 8.0 to 8.3 in the ordinary way, it took 2 hrs. 38 min. to settle at a turbidity reading of 2.6 cm.

Under these conditions the tonnage of cane had to be reduced and the mills shut down to clear the settling tanks. Various measures were tried to improve matters. Dividing the application of lime before and after heating the juice gave a better settling, but the volume was so great that the juice from the lower valve of the tank was never clear. Addition of double superphosphate to the limed juice was beneficial, but the volume of settling was still large and the juice from the lower valve did not run clear.

Addition of bagasse screenings to the juice in the settlers was not beneficial from the clarification standpoint, but fine bagasse added to them prior to filtration reduced polarization in cake. When POJ 2878 is mixed with other canes, such as Yellow Caledonia and POJ 36, in the proportion of 25 to 30 per cent. the clarification is just as good as that of Yellow Caledonia or POJ 36 alone. The presses, however, do not function well, and the polarization is usually higher.—(*Int. Sugar Jr.* Vol. XXXVI, No. 431, pp. 446-7, 1934.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Germany Producing Sugar from Wood.

The production of sugar from wood by the well-known Bergius process has received favourable attention of the Reich Government and will in future receive all the benefits and concessions accorded to the beet-sugar industry, according to a report made public by the Department of Commerce. Special tax exemptions granted by law to new processes and inventions creating new industries are expected to be important factors favouring development of this new source of sugar.

Cattle fodder produced as a by-product of this process is said to have attracted the attention of agriculturists. The German Agricultural Council has instituted investigations regarding its practicability, and the Reich Food Bureau is expected to establish a good foundation for its development.

The Deutsche Bergin A.-G., of Ludwigshaven, undertook the practical exploitation of the process and has already concluded contracts with the I.G. Farbenindustrie covering small deliveries of the product needed by the latter because of certain advantages it offers in replacement of other materials for certain chemical uses. The productive capacity of the Mannheim-Rheinau wood-hydrolysis plant is to be increased and other plans involve the establishment of a wood-sugar plant at Regensburg.—(*Industrial and Engineering Chemistry*, News Edition, Vol. XII, No. 18, 1934, pp. 340.)

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Absorption of Manganese by Plants.

A valuable contribution to the literature on the effects of manganese in plant growth appears in a recent paper by Carsten Olsen (*C. R. Trav. Lab. Carlsberg*, 20 (2), 1-34; 1934). A survey of the manganese content of leaves from a number of land plants from natural soils of different pH values shows that increase in soil acidity is accompanied by increased absorption of manganese, due presumably to the increased concentration of soluble manganese salts in the soil solution. Plants from basic soils show a very small manganese content. Iron content, on the other hand, seems to bear no consistent relationship to hydrogen ion concentration. Similar results were obtained with artificial soils in pot experiments with barley and buck-wheat. Plants grown in water cultures of different pH but constant manganous sulphate concentration show a maximum manganese absorption at pH 6-7. The absorption increases with increase of manganese concentration in the medium. Manganese is probably absorbed as manganous ion, manganous salts being stable in acid soil. Hence water and swamp plants contain large amounts of manganese, even when grown in a neutral or basic medium, provided the latter is deficient in oxygen and oxidation of manganous salts to manganese dioxide is retarded. Plants grown in cultures free from manganese do not develop chlorosis, which seems to depend rather on the ratio of iron to other absorbed ions, but suffer from 'grey speck disease'. When developed in basic soils (for example, by oats), the disease is less serious in moist or clay soils where access of oxygen is diminished.—(*Nature*, Vol. 134, No. 3386, p. 465, 1934.)

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Vitamin C Content of Citrus Fruits.

By a titration method, it is possible to measure directly the content of ascorbic acid (Vitamin C,) in plant products. The method has recently been applied to a comparison of various citrus fruits and citrus products (A. L. Bacharach, P. M. Cook and E. L. Smith, *Bio-chemical Journal*, 1934, Vol. XXVIII, No. 3, p. 1038). The following results were obtained; the values given are milligrams of ascorbic acid per cubic centimetre of juice. Orange, 0.22 to 0.89 (mean 0.51); tangarine 0.10 to 0.78 (mean 0.37) and lemon 0.47 to 0.73 (mean 0.64). Storage for one month causes a loss of ascorbic acid in the fruit of nearly 20 per cent. for oranges, but only six per cent. for lemons. Negligible loss occurs on concentrating and storing orange juice. Marmalade was found to contain 0.06 to 0.14 milligrams of ascorbic acid per gram, the richer kinds containing the most peel. For all citrus fruits examined, the outer coloured rind layer contained most ascorbic acid the white layer the next, and the juice the least, whilst the seeds contained none.

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Chlorinated Rubber.

The new chlorinated rubber known as Alloprene lately introduced by Imperial Chemical Industries Ltd., is the first solid product of its kind to be manufactured in this country. Alloprene possesses a number of interesting properties which should make it useful for a wide variety of industrial purposes. As at present produced, it is a white, fibrous material containing from 65 to 66 per cent. of chlorine, and having a composition corresponding approximately to $C_{10}H_{13}Cl_{17}$, both addition and substitution occurring at the same time in the chlorinating process. It is claimed to be remarkably resistant to attack by acids and alkalis at ordinary or higher temperatures; for example, concentrated nitric acid is stated to have practically no effect on Alloprene at 80°-90°C. and it is unchanged after heating with 40 per cent. caustic soda solution for several hours. Hydrochloric acid at all concentrations does not attack Alloprene at temperatures up to 100°C., and no discoloration results from 98 per cent. sulphuric acid at ordinary temperatures even after several days' contact. Alloprene is equally resistant to aqueous solutions of oxidising agents such as permanganate, or the hypochlorites and bichromates, and it can also be safely used in contact with such corrosive gases as oxygen, chlorine and sulphur dioxide. Furthermore, Alloprene shares with many other chlorinated products the property of non-inflammability; in prolonged contact with a naked flame it carbonizes without burning or fusing.—(*Chem. & Ind.*, Vol. 53, No. 36, 1934, p. 761.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.— Prices on the Home Markets have ranged as follows (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
25th October	4 1½	7 9½
1st November	4 0	7 9
8th November	4 0¾	7 9¾
15th November	3 11¼	7 8¼
22nd November	4 3¾	8 0¾
29th November	4 3¾	8 0¾
6th December	4 3¾	8 0¾
13th December	4 3¾	8 0¾
(*14th Dec.*, 1933)	4 7½	9 3

A new low record with sales of November sugars at 3*s.* 10½*d.* c.i.f. has been established. The decline in quotations has, however, been checked and during the week ending 22nd November a welcome uplift of prices was experienced, values of nearby raw sugars appreciating 3¾*d.* per cwt. According to *C. Czarnikow, Ltd.* this rise has been partly in the nature of a reaction from recent depressed levels. The condition of stagnation in the raw market had encouraged refined sugar distributors to let their stocks diminish to a point where replenishments could not be deferred much longer and the presence of this potential buying movement in the background rendered the market susceptible to any favourable development. This materialised in the form of certain proposals put forward by the domestic beet interests to spread the deliveries of raw sugars over a longer period with a view to alleviating the pressure of arrivals of domestic and Empire sugars, which has always been an unfavourable influence in the sugar market during the winter months.

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COCOA.—Since last report the London Terminal market fluctuated somewhat but the undertone of the Accra market remained quite steady and later advices report a firm and active market owing to American demand and firm attitude of shippers. The price now quoted for Accra cocoa is 21*s.* 6*d.* whilst locally $6.20 a fanega is paid for Plantation.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

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BANANAS.—The demand is quieter as a result of the cold and foggy weather, and prices of Jamaicas are unchanged at £17 5*s.* per ton delivered London, or £17 nearest station Provinces. Brazilians are in fair demand and unchanged at £18 nearest station. The total imports into the United Kingdom for the first ten months of the current year were 14,618,263 bunches, of which 8,306,733 bunches came from the West Indies.—(*West India Committee Circular*, 22nd November.)

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
31st October	6 7-16
7th November	6 7-16
14th November	6 3-8
21st November	6 3-16
28th November	6 3-16
5th December	6 3-16
12th December	6 3-16
(*13th Dec.*, 1933)	4 3-16

The market has developed a somewhat easier tone following upon the announcement that the International Rubber Regulation Committee had failed to come to an agreement on permissible exportable percentages. In addition, nervous selling has brought quotations down. Up to September shipments stood at 765,440 tons and consumption at 721,000 tons.

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COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
26th October	6.92	8.22
2nd November	6.79	8.32
9th November	6.81	8.66
16th November	6.88	8.80
23rd November	6.91	9.11
30th November	7.03	—
7th December	7.04	—
14th December	7.07	—
(*15th Dec.*, 1933)	5.25	7.16

Raw prices have tended to harden partly owing to the proposals in the United States of America to exchange cotton for German goods, chiefly chemicals. Spot demand in Liverpool is still chiefly centred on outside growths.

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COFFEE.—Demand has again been slow and only a portion of the offerings have found buyers. Parcels of the new Costa Rica crop at 72*s.* and 74*s.* 6*d.* went rather cheaply.

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LIME PRODUCTS.—*Lime Oil.* Handpressed is valued at 32*s.* 6*d.* Sellers of Distilled are asking 20*s.*, but they invite bids. *Lime Juice.*— There are buyers of Concentrated at £4 15*s.* Raw is quoted nominally 2*s.* to 2*s.* 6*d.* according to quality.— (*West India Committee Circular*, 22nd November.)